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Environmental Migration From Egypt and Morocco: A Comparative Study

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Abstract

As economies continue to industrialize and grow, human activity and general changes in weather patterns have had an adverse effect on the global climate. Global temperature continues to rise creating changes in the climate of many different areas of the world, increasing the intensity of sudden and slow onset disasters. Less developed countries in the Middle East and North Africa particularly Egypt and Morocco are two economies that are negatively affected by certain dimensions of climate change. These dimensions of climate change have direct implications on internal and international migration patterns of these countries. Both countries rely on agriculture as a large part of their economy, and as climate change becomes worse, it will lead to an increase in climate migrants within these countries. Climate change will exacerbate migration, which will become a global crisis by the end of the 21st century due to the staggering number of climate migrants that will emerge.

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Table of Contents

Introduction

Climate change is currently one of the leading environmental and political issues that the world currently faces. The earth is continually getting hotter as greenhouse gasses continue to destroy the world's ozone layer. Climate change is one political issue that is always in conversation as it has prolonged effects on the economic and political landscape of many nations. Certain nations can deal with the consequences of climate change depending on resource availability and the development of the nation as a whole. The way that nations can cope with the effects of climate change depends on the vulnerability of that nation. The vulnerability of a country to climate change can be based on the location of the nation and its overall stability. This refers to the stability of political, economic, and social forces within the given nation that can influence post-disaster human security (Raleigh et al.). Nations that do not have strong economies, or are dealing with political issues such as corruption find it harder to cope with the negative effects that climate change may have.

Apart from the obvious places in the world such as Antartica that are facing intense changes in the environment, the Middle East and North Africa (MENA) region is another place where the effects of climate change are intense. Some of the effects due to climate change in this area include elevated temperatures, lower levels of precipitation, rises in sea level, droughts, and flooding. These changes in the environment, also considered environmental degradation has short run and long run effects on the political and economic landscape of the countries within the MENA region. These short run and long run effects include changes in migration trends throughout the region.

Migration is considered a coping mechanism as individuals try to deal with environmental changes. Migration can also be seen as a strategy to diversify income. Migration

helps improve the employment and earnings prospects of those individuals choosing to migrate, and in turn, can also help family through remittances. About one-fifth of migration that occurs in the world today is driven by climate change. Migration within this region occurs due to the effects that climate change has on resource availability throughout the region. The MENA region relies heavily on water as agriculture is a sector that is the driving force of many economies. This region specifically faces increased frequency of droughts which forces individuals and families within this region to migrate to find job opportunities that are otherwise lost due to lack of resources.

Within the MENA region, two countries stand out as from the rest as migration patterns play a large part of the economy and influence politics. These two countries are Morocco and Egypt. This paper will go on to define climate change, and identify the certain dimensions and channels of climate change. Then the dimensions of migration will be analyzed to understand how climate change can shift migration trends. It should be noted that there are implications in this comparative analysis and the relationship between climate change and migration. Climate change is very unpredictable, and it is difficult to understand the changes in the climate over a period. Although all signs point to higher temperatures throughout the world in the future, its is difficult to predict how much the climate will change considering the actions of humans. Humans have a large impact on the climate and changes will be determined depending on changes that nations make to reduce variables that intensify climate change. In the same context, it is also hard to predict the actions that individuals take in the face of environmental degradation. The decision making of families and individuals remains variable since religion and family are such strong factors throughout the region. The decision making of individuals and the uncertainty of climate change make it difficult to project future trends. However, the nexus between migration

and climate change does exist, and this paper will explore this nexus in the countries of Morocco and Egypt.

Chapter 1: General Dimensions of Climate Change

Climate change is a phenomenon that is occurring across the world and has varying effects on different economies. The latest annual average temperature recorded in 2015 stood at about .87 degrees Celsius. In comparison 20 years ago in 1995 the annual average temperature stood at .46 degree Celsius. This increase in global temperature can be seen in graph 1.1. This graph (provided by NASA) shows that the annual global temperature is rising, and has been rising at a faster pace in the last 20 years. This increase in temperatures is due to the greenhouse gas effect. Through the activities of humans such as burning fossil fuels and deforestation, Carbon Dioxide (CO2) (a heat-trapping gas) is emitted into the environment. Fossil fuels burned in factories produce CO2, and deforestation by humans lowers the amount of CO2 that plants intake, leaving it in the atmosphere. This greenhouse effect and pollution in the environment have set the Earth on pace to reach an annual average temperature of 2 degrees Celsius by mid-century. If actions are not taken by nations to reduce pollution, and emissions of fossil fuels into the environment, there is a possibility that the Earth's annual temperature will rise to 4 degrees Celsius by 2100 (World Bank, 2014). This increase to a global temperature of 4 degrees Celsius is shown in graph 2.2. This figure shows the increase of temperatures to 4 degrees Celsius under current climate policies. As this warming occurs there will be dramatic shifts in climate that will make certain parts of the world uninhabitable due to extreme temperatures, and natural climate shocks that take place.

According to NASA, entering the month of June in 2016, the Earth was facing a 14-month global heat wave. The first six months of 2016 were the hottest ever recorded making it clear that climate change is actively shifting weather patterns throughout the world. One of the reasons that global temperatures are rising can be attributed to a change in the Earths rotation. In a study done by NASA, it is understood that the Earths rotation has been slightly changing over time. The mass lost from the Greenland and Antarctic ice sheets due to climate change influences shifts in the rotation of the Earth. Around the year 2000, the Earths spin turned towards the east and started to drift twice as fast at a rate of about 7 inches (Adhikari and Ivins 2016). As ice sheets, and glaciers continue to melt, the addition of water has a pull effect on the rotation of the Earth pushing it towards the east (Adhikari and Ivins 2016). This change in rotation can be attributed to why pressure systems are not moving as quickly as they should be. This change in rotation likely influences wind patterns by weakening them, which in turn allows high-pressure systems to sit over areas creating heat waves. As the climate continues to get warmer and the mass of ice sheets and glaciers around the world continue to decrease, the rotation of the earth will continue to shift. This shift will change and intensify certain weather patterns globally. If human activity does not shift to cleaner technology, this process will continue and will complicate social and economic demographics.

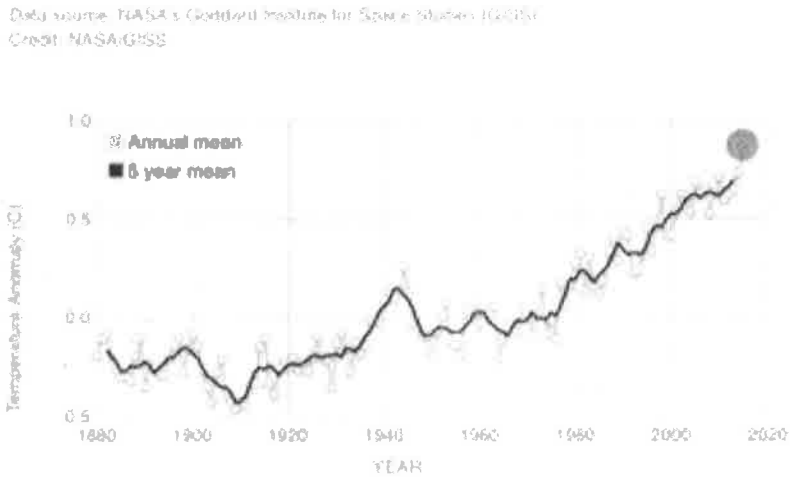
As global temperatures continue to increase, the contribution levels of individual economies to overall global warming must be examined. According to the Environmental Protection Agency (EPA), in 2013 the United States, China, and the European Union (EU) accounted for 54 percent of all CO2 emissions from fossil fuel combustion and industrial processes. All other countries combined accounted for the other 46 percent, with India and Russia both contributing 6 percent. This contribution to global warming must is analyzed

because those countries contributing the most are the ones that have resources to mitigate the effects of climate change. The United States, China, and most countries in the European Union are all considered developed economies that are technologically advanced and can find ways to counteract the effects of climate change. On the other hand, the countries that contribute minimally to global warming are the ones that will potentially be affected the most by climate change. These countries include those in the Middle East, North Africa, Southeast Asia, and in South America. There is ongoing controversy regarding carbon emissions as countries that minimally contribute to climate change believe that they should not be held to the same standards as the United States, or China. This paper will focus on the MENA region specifically Egypt and Morocco. These are two countries that minimally contribute to climate change, and yet will be affected dramatically by climate change in the future. At the same time, migration levels in these two countries will be shifted as well, as the emergence of climate migrants will continue to increase. This understanding of the contribution of carbon emissions to global climate change by country helps to emphasize the importance of the effects of climate change on developing economies such as Egypt and Morocco.

This rise in the temperature of the earth leads to both sudden onset disasters and slow-onset disasters. Sudden onset disasters are events such as hurricanes, floods, earthquakes, or even volcanic eruptions. Contrasty, slow onset disasters include droughts, land erosion, increased soil salinity, or changes in rainfall patterns. Climate change exacerbates sudden and slow onset disasters. Each of these climactic events leads to the deterioration of economies throughout the world. As countries go through certain climatic events or changes, many economies are not developed enough or do not have sufficient resources to react as soon as possible. Countries who are facing high levels of poverty are apt to be more vulnerable to climate change. The

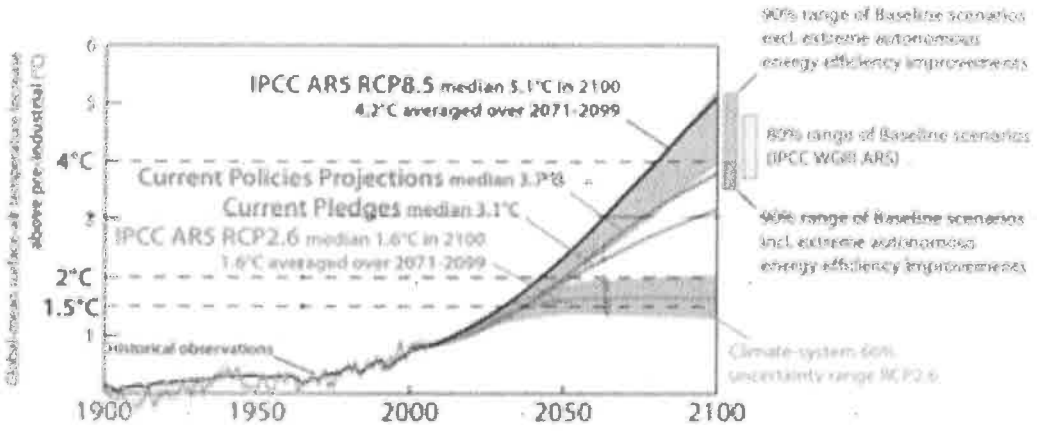
vulnerability of an economy to certain dimensions of climate change goes hand in hand with resource availability in the economy, and overall geography as well. Countries who do not have the resources to counteract the effects of climate change, or respond to sudden climactic events will be more vulnerable. With that in mind, it is important to note that different economies react in certain ways to climate change. These dimensions of climate change will be analyzed further to emphasize the impacts that such climatic events can have on individual economies. Each of these dimensions of climate change has a direct correlation to migration patterns for individual economies throughout the world.

Graph 1.1: Global Land-Ocean Temperature Index



Source: NASA

Graph 1.2: Projections for Global Temperature 1900-2100



Source: World Bank, 2014

1.1 Sudden and Slow Onset Disasters

Climate change has a direct impact on weather patterns throughout the world as it triggers sudden and slow onset disasters. Sudden onset disasters or also known as climate events include floods (monsoon or glacial), storms, hurricanes, typhoons, earthquakes, volcanic eruptions, wildfire, extreme temperatures, and tsunamis. The spontaneity of these natural disasters places these events into the category of a sudden onset disaster. These events trigger evacuations on short notice and give governments and individuals minimal response time. Individuals are forced to move and or evacuate areas to survive these natural disasters. One the other hand, there are slow onset disasters. Slow onset climate change also known as climate processes are changes in the environment that occur over an extended period. Such climate processes include rises in sea levels, salinization of land, desertification or droughts, and changes in rain patterns. These shifts in the environment occur over time which allows nations to adapt or use resources to counteract the effects. In comparison to sudden onset climate change, the vulnerability of individual nations is lower since there is ample time to react to these events. The dimensions of slow onset climate change include rises in sea level, desertification or droughts, changes in rain patterns, and the

salinization of land. These dimensions of climate change will be analyzed to understand how climate change triggers sudden onset disasters, and at the same time how environmental degradation has long-term impacts that lead to slow onset disasters or climate processes.

Sudden onset disasters are climatic events that take place in short notice and limit the ability of the affected country to respond to the disaster. These disasters include heat waves which can instigate wildfires, hurricanes which in turn can lead to flooding, earthquakes, and or volcanic eruptions. Of these sudden onset disasters, heat waves and hurricanes or tropical storms are two dimensions of climate change that have the most influence on migration patterns. These events force people to move as the risk of staying in this affected area is too high. However, in the short term, these events often lead to temporary migration by individuals. Families move out of the region for a period of time until the disaster passes or the destruction of the event has been nullified. Often long term or permanent migration occurs when individuals see that the frequency or intensity of these events increases. Families in less developed countries that face high levels of poverty are more often to migrate permanently to other areas, as remaining in the affected area, or home country proves to be too risky. Sudden onset disasters or climate events impact migration, however, tend to instigate more short term movement. These short term patterns will eventually turn into permanent migration as climate change continues to shift weather trends. These sudden onset natural disasters will intensify and increase in frequency, displacing families and individuals resulting in an increasing number of climate migrants. These dimensions of climate change must be analyzed to understand the effects that each has, and how these effects, in turn, displace individuals in the affected areas.

1.2 Sudden Onset Disasters: Extreme Temperatures

The first dimension of climate change that should be analyzed are extreme temperatures. As mentioned earlier, the climate of the Earth continues to get warmer. While this being the case, it is critical to understand how extreme temperatures are continuing to have an adverse effect on economies throughout the world. As mentioned earlier, according to NASA the current global temperature stands at approximately .87 degrees Celsius. Although this may not be alarming to many, the implications if the global temperature were to reach 2 degrees Celsius or even 4 degrees Celsius would be catastrophic. While these projections of global temperatures reaching 2 to 4 degrees Celsius would not occur within the next 100 years or so, it is important to analyze how climate change is currently resulting in extreme temperatures throughout the world. Extreme temperatures and or heat waves are one of the results of an increase in the global temperature. Over the past 50 years, heat waves have become more frequent throughout the world, and this trend can be attributed to climate change. The implications of heat waves on the lives of individuals and economies should be considered as it is an important dimension of climate change that also instigates migration.

According to the NOAA, a heat wave is defined as a period of unusually hot temperatures that lasts more than two to three days. Heat waves are generated and determined based on pressure systems that exist throughout the Earth's atmosphere. Pressure systems are the way that local temperatures and climates are determined as low-pressure systems go hand in hand with cloudy, and wet conditions, while high-pressure systems are associated with clear and warmer conditions. High-pressure systems are directly associated with heat waves that occur. High-pressure systems force air downwards and do not allow air from the ground to rise. This leads to lower levels of evaporation which contribute to lower levels of precipitation. The air that is being

pushed downward onto the ground acts like a cap and traps the warm air on the ground in place. With this "cap" in place, there is nothing to stop the air on the ground from getting hotter. Winds tend to push these pressure systems along making it so that they are never situated over a particular area for an extended period. While this is phenomenon is supposed to last for a short period, if weather patterns are unable to push these high-pressure caps away they result in heat waves that last for days or even weeks. If the Coriolis Effect[1] becomes weaker and weather patterns are unusual, high-pressure systems will remain over situated areas for an extended period creating heat waves. Now that it is understood how heat waves occur, it is critical to analyze why the frequency of heat waves throughout the world has increased.

The period in which heat waves last can range from 3 days to many weeks which can have profound negative effects. First off, the areas that are highly affected by heat waves and extreme temperatures are areas with urban infrastructure. In cities and urban areas, there is higher human activity which in turn lead to a phenomenon called the "heat island" effect. With higher levels of human activity, there also tends to be higher levels of pollution which contribute to high levels of humidity and heat. According to the EPA, cities with a population of 1 million or greater tend to be 1.8 to 5.4 degrees Fahrenheit warmer and a dramatic 22 degrees Fahrenheit warmer during evenings than areas that surround those cities. Heat waves according to the Center for Climate Research, kills more people per annum than all other natural disasters combined in the United States. In countries that are less developed, these heat waves affect the health of individuals even more as families must often travel long distances to obtain certain

[1] The Coriolis Effect is the phenomenon that describes air that is deflected in the Northern and Southern hemispheres due to the rotation of the Earth. This phenomenon is responsible for wind patterns throughout the world, which in turn influence ocean currents. The reason that heat waves are becoming more frequent is due to the weakening of winds throughout the world. As wind speed and intensity continue to decrease, this allows high-pressure systems to sit over certain areas causing heat waves.

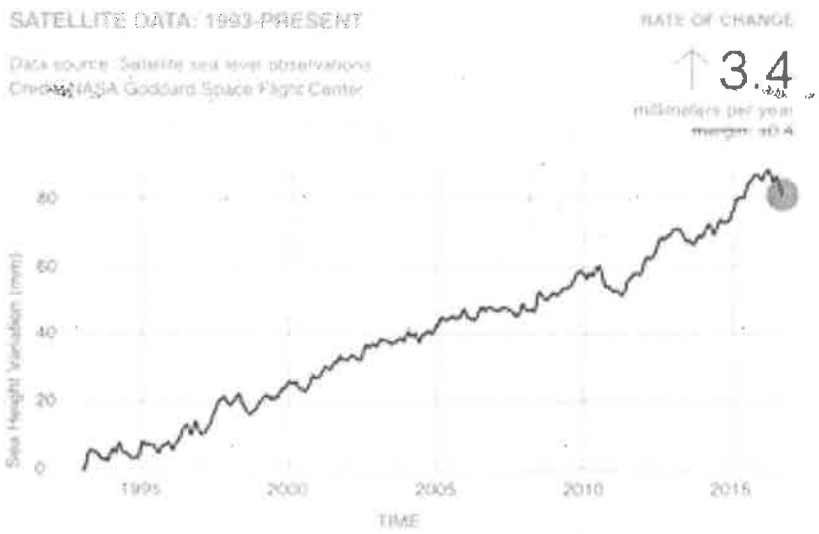
resources such as drinking water, and food. The distance traveled can at times be miles, and in countries where transportation technology is still inefficient most individuals must walk in these extreme temperatures leading to sickness and at times death. Heat waves have adverse health effects, and also impacts economies that are reliant on agriculture to sustain a way of life. Heat waves also induce long-term droughts; however, this dimension of climate change will be discussed later on in the chapter. Heat waves in the short term, kill crops and livestock due to the extreme heat that lasts longer than usual. As these heat waves become more intense and more frequent, more climate migrants will continue to rise. As agricultural efficiency declines due to heat waves, individuals will choose to migrate to another area as a long term solution. Heat waves have direct implications on the health of individuals in both less developed countries and developed countries. In less developed countries where agriculture is a larger part of the economy, heat extremes directly lead to the death of crops and livestock making it harder for these families to sustain a stable way of living. As mentioned before heat extremes do in fact influence droughts, however, this slow onset disaster will be examined in upcoming sections.

1.3 Slow Onset Disasters: Rises in Sea Level

As the temperature of the world continues to increase, and CO2 emissions continue to rise, the Earth is faced with large-scale changes in its ecosystem. These changes are considered irreversible and will have permeant economic impacts on nations in the future. One of the dimensions of climate change that is seen as irreversible is a rise in global sea levels. According to NASA, an increase in sea level is attributed to two factors. The first factor that attributes to rises in sea levels is the rise of temperatures in water that expands oceans. This is known as thermal expansion. The science behind thermal expansion is that greenhouse gasses that trap heat

are mostly absorbed by oceans. As oceans absorb more greenhouse gasses, water temperature rises which leads to an increase in water volume. Thermal expansion contributes to rises in sea levels although it is not the primary factor to why sea levels continue to rise. The main factor that contributes to rises in sea level are melting ice sheets and glaciers. As global temperatures continue to rise, glaciers and ice sheets melt which in turn increase the volume of water on Earth. According to NASA, in January 1999 sea-levels were recorded to be at 19.7 millimeters which is low considering that as of July 2016 sea levels are at 84.8 millimeters. This increase in sea level is shown in graph 1.3. It is apparent that there is an upward trend in the graph and that sea levels are rising at an alarming pace. Sea-levels are consistently rising and will continue to rise as the Earth warms. It is projected that in a world where the average global temperature is 2 degrees Celsius sea levels would rise to about 3.6 meters and about 8 meters in a 4 degree Celsius world (World Bank 2014). Something that should be noted is that rises in sea level are not consistent across the globe. This is attributed to the fact that ocean temperatures vary and heat from climate change is not stored equally around the world. Certain regions will, in fact, face larger increases in sea level while other areas will not see effects as dramatic. This deviation from global sea level rise is dependent on local land elevation where certain areas face greater or lower sea level rises. With this in mind increases in sea-level have the largest impact on coastal regions, and those regions who already stand well below sea-level.

Graph 1.3: Sea Level Height Variation
(1990-2016)



Source: NASA

Rises in sea level are apparent, as there is a 3.4-millimeter change in sea level per year according to NASA. While this is the case, it is important to analyze the factors that attribute to this rise in sea level across the globe. As previously mentioned the two main factors that attribute to rises in sea levels are thermal expansion and melting ice sheets and glaciers. The first factor of thermal expansion occurs relatively slowly. However, it is the increase in greenhouse gasses that cause this process to expedite. As more greenhouse gasses are emitted into the environment, the ocean is forced to absorb more of these gasses. At the same time due to human involvement, the number of trees within the environment also continue to decrease. This intensifies the pressure on oceans and also intensifies the process of thermal expansion causing sea levels to rise at a faster pace every year. However, it is melting ice sheets and glaciers that are having the most influence. The largest ice sheets in the world belong in Antartica and Greenland. Ice sheets are defined as a mass of glacial ice that extends for more than 50,000 square kilometers. As of today, there are only two ice sheets that exist in the world known as the Greenland ice sheet, and the Antarctic

ice sheet. These ice sheets contain more than 99 percent of the freshwater on the Earth. The Antarctic ice sheet extends for almost 14 million square kilometers while the Greenland ice sheet extends for about 1.7 million square kilometers. The melting of these ice sheets significantly contributes to rises in sea level.

Rises in sea levels have numerous local effects that impact economies that mainly reside on coastlines. One of the large effects of rising sea levels is the higher rate of tides. Tides can be defined as waves that are generated by the gravitational effects of the sun and moon, and are influenced by the Earths rotation. Tides vary over time depending on the region and ocean circulation within that region. As sea levels rise, tides increase and create a higher risk for flooding in coastal regions. Another effect of rises in sea level would be an increase in frequency of storm surges and a higher intensity level of these storm surges. A storm surge is a higher than normal rise in coastal waters, on top of tides that already exist. These storm surges are instigated by high wind patterns usually brought upon by tropical storms or hurricanes. These strong winds push water towards the coast of certain areas creating large waves that can have devastating effects on coastal regions. Storm surges usually instigated by storms present problems for coastal economies, as higher intensity storm surges have the potential to destroy infrastructure, and displace individuals both permanently and temporarily. Rises in sea level leave lots of areas throughout the world vulnerable to these effects as several underdeveloped economies reside below sea level. The United States is one country that is vulnerable to rises in sea levels, but it is still a developed country that has the resources to mitigate these effects in the short and long term. Countries within southeast Asia (specifically Bangladesh) are vulnerable to climate change as well and are not as developed as the United States. The effects of rises in sea levels in correspondence with climate change throughout Bangladesh will be analyzed to understand the

severity and intensity that such climatic changes can have on an economy, specifically the economy of Bangladesh.

Situated in Southeast Asia, Bangladesh is a country that is immediately confronted with changes in climate today. Currently, Bangladesh is considered the country that faces the highest risk of being dramatically affected by rises in sea level due to ice and snow that melts off the Himalaya mountains. Before diving into the effects of higher sea levels, Bangladesh's economy should also be analyzed in to understand the implications of climate change. Bangladesh is poverty stricken, and has districts throughout the country that are very densely populated. Due to lack of innovation and resources, Bangladesh relies on its agricultural sector as a primary source of revenue. Up to 80 percent of the population in Bangladesh reside in rural areas, and about 45 percent of the labor force is employed in the agricultural sector. The country is made up of low-lying riverine land that due to its proximity to the Bay of Bengal making its the ideal place for farming. At the same time, its proximity to the bay makes the country more vulnerable to rises in sea level. Bangladesh also makes itself more vulnerable to sea level rise since it pumps groundwater for drinking supplies since the majority of rivers are polluted and are not safe to drink from. This water that is pumped up from the ground causes the land to settle. As water is continuously extracted from the ground the land throughout Bangladesh sinks as sea levels, continuously rise. The obvious problem is that sea level rise creates issues for the agricultural sector of the Bangladesh economy. As sea levels rise, crops and infrastructure are damaged due to how underdeveloped technology is throughout the country. The infrastructure is poorly built, due to lack of resources which make the country more vulnerable to the effects of rises in sea levels. According to the Intergovernmental Panel on Climate Change (IPCC), a 45 centimeter rise in sea level will inundate about 10.9 percent of the territory throughout Bangladesh resulting

in the displacement of about 5.5 million individuals throughout the country. As water continues to envelop land throughout the country, individuals will need to migrate to high land. Rises in sea level will instigate more storm surges, floods, and typhoons that will and can ultimately displace millions of individuals throughout Bangladesh and other countries in the future.

1.4 Slow Onset Disasters: Shifts in Rainfall Patterns

Changes in rainfall and precipitation levels is another dimension of climate change that is considered a slow onset disaster. Changes in rainfall occur over the long term[2] which is why it is considered a slow onset disaster; however shifts in rainfall can lead to other sudden onset and slow onset disasters. Shifts in rainfall can influence droughts which are considered a slow onset disaster, while it also influences flooding which in turn is a sudden onset disaster. Rainfall variability is a dimension of climate change that has a direct and significant role in the availability of water. Less developed countries rely on runoff from mountains as a source of water, or base water availability on rainfall to support sectors of the economy such as agriculture. In many cases agriculture is the focal point of the economy for these less developed countries due to lack of technological innovation and lack of industrialization. Due to this, rainfall has a major effect on migration patterns of many countries and has direct implications on agricultural efficiency. Areas such as Central America, the Caribbean, the Western Balkans, and the Middle East and North Africa are hotspots where precipitation is projected to decline 20–50 percent in a 4°C world (World Bank 2014). While rainfall directly effects whether or not countries go

[2] In the case of low pressure systems, warm air ascends from the Earths surface rather. This rise in warm air eventually cools off which in turn leads to the formation of clouds creating rain showers. As mentioned before in the study done by Adhikari and Ivins (2016), continuous melting of ice sheets will create a shift in the Earths rotation leading to variable formations of pressure systems, and weather patterns. Just as changes in wind patterns would not push high pressure systems away causing heat waves, low pressure systems would not be pushed away causing extended periods of rainfall leading to an increased risk of flooding.

through periods of droughts, it also has a direct effect on flooding as well. While the areas mentioned above may face declines in precipitation, as the global temperature rises countries will also see dramatic increases in precipitation levels. Central and Eastern Siberia and northwestern South America will face dramatic increases resulting in a 30 percent increase in precipitation intensity in a 4°C world (World Bank 2014). These changes in rainfall patterns will directly leave countries at higher risk of droughts and flooding and will in turn influence agricultural production. A perfect example of changes in rainfall is India as the country is facing dramatic shifts in precipitation leading to both flooding and droughts. India relies on its monsoons as a source of water, however the variability of these monsoons have been either leaving India flooded or arid. This variability of these monsoons will be assessed to understand how rain variability has plays a significant role in the way individuals migrate and must cope with these changes.

India is a country that relies heavily on agriculture as a major staple of its economy. According to the World Bank, about three-fourths of Indian families rely on rural incomes due to the vast majority of the population living in poverty (about 70 percent or 770 million individuals are found in rural areas). Since this is the case, millions of individuals rely on consistent monsoons to be able to farm efficiently and be able to sustain a stable living situation. India is considered an agricultural powerhouse as it leads the world in the production of many spices, and grains. At the same time, the 63 percent of the countries cultivated area is rain-fed. This emphasizes how important rainfall is to the economy and how variability can cause social and economic issues. In a 2°C world, monsoons would become very unpredictable leading to unexpected droughts and floods. In comparison in a 4°C world, it is projected that extremely wet monsoons that were to occur every 100 years would occur every ten years by the end of the

century (World Bank 2014). These changes in monsoon patterns directly influence migration in India due to these natural disasters. As flooding occurs due to extended monsoons, individuals whose homes are destroyed must migrate out of the affected area. In coherence with this, migration in India is also just as variable as rainfall.

1.5 Slow Onset Disasters: Droughts

One of the larger dimensions of climate change that have a direct impact on human migration and environmental degradation are droughts. As mentioned earlier, droughts are influenced by extreme temperatures which make resources such as water unavailable for extended periods of time. In comparison to heat waves that are influenced by extreme temperatures, a drought is considered a slow onset disaster. According to the NOAA, a drought is defined as a deficiency in precipitation for an extended period (usually for a season) which in turn results in water shortages that have negative impact on people or agriculture. As record-breaking temperatures continue to be a common trend throughout the world, drought prone areas are at higher risk. As global temperatures continue to increase with the potential of global temperatures reaching 4 degree's Celsius in the next 100 years, there will be an increase in intensity and duration of droughts (World Bank 2014). Graph 1.4 support this claim. In a visualization of the world, the World Bank shows how the duration of droughts will be extended under the conditions of a 4 degree Celsius world. As mentioned before, changes in weather patterns influence the intensity and duration of heat waves, which in turn can also impact the intensity and duration of droughts. As precipitation levels become more variable, areas that are dependent on rainfall for agriculture must find other ways to farm or obtain water. More often

than not, individuals that are faced with changes in rain patterns, and are experiencing droughts must migrate to areas that are not affected. This is one of the only ways to mitigate the effects of droughts, since staying the affected area would minimize profit for those that rely on agriculture as a source of income. This is especially the case in countries that considered by definition "less developed" as resources may already be scarce. While current countries such as those in the Middle East are suffering consistent droughts, one of the largest droughts occurred in the 1930's in the United States. This event is now known as the Dust Bowl due to the severity of the drought at the time. This event in American history will be analyzed to show the nexus between human migration and the effect that droughts had on resource availability. It should be noted that the Dust Bowl was also an event that was the cause of human error. Westward expansion and the demand for wheat influenced the movement of thousands of families to the Great Plains to purse a life of farming. The amount of dry-land farming at the time along with overgrazing caused the destruction of the natural prairie grasses which in turn intensified the effects of the drought.

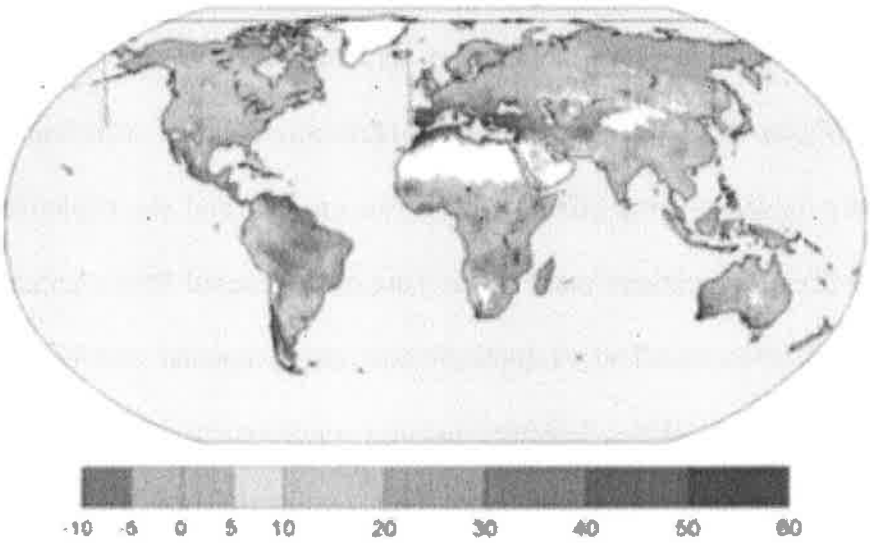
In the 1930's the United States was faced with the crash of the stock market, which eventually forced the country into a depression which is now known as the Great Depression. This depression is the longest lasting economic downturn in the history of the western industrialized world. While the economy was stagnating, and over 10 million people were left unemployed another major issue arose in the western part of the country. A severe drought had hit the Great Plains in the United States which accounted for about 150,000 square miles. The drought caused rainfall to become very rare, which in turn caused the soil to become light. At the same time, strong winds picked up the loose soil creating dust clouds that would engulf regions. As the land became barren, sustaining farms and using agriculture as a form of revenue became nearly impossible. Agricultural production throughout the Great Plains declined as farming was

impossible due to the conditions of the drought. Not only were individuals not able to farm, but the dust storms that give this period its name, consistently destroyed infrastructure creating an unstable lifestyle in this region. This forced millions of individuals to migrate from the affected area creating a mass exodus from the plains. Individuals within the Great Plains simply abandoned their land, gathered their belongings, and migrated elsewhere. This migration of people out of the Great Plains is known as the largest migration in American history as 2.5 million individuals moved out the affected area. The drought and the depletion of resources created unfeasible living conditions making this part of the United States uninhabitable at the time. The dust bowl is an excellent example of how environmental conditions have a direct relation to migration patterns. Water depletion and arid conditions give individuals no choice but to migrate to other areas that provide the resources for a stable lifestyle. As mentioned before the Dust Bowl was caused due to human error and is not directly correlated to climate change. While this is true, it does show how environmental degradation within an area leaves individuals with limited options, where migration is often the most efficient way to cope with the effects of droughts.

Furthermore, these dimensions of climate change that were divided into sudden and slow onset disasters directly influence change in migration patterns. The climate shocks will occur in the future due to increases in global temperature that will ultimately displace millions of people if actions are not taken. Now that the general dimensions of climate change are understood, an analysis of the definition of refugee's and migrants will be done. As climate change continues to displace more individuals, controversy grows due to the fine line that is drawn between a refugee and a migrant, as those displaced by climate change are not considered refugee's. The definition

of a refugee and migrant will be explained to further understand the nexus that exists between conflict, climate change, and migration.

Figure 1: Duration of Drought Conditions in a 4°C World



Source: World Bank, 2014

Chapter 2: Dimensions of Migration

2.1: Theoretical Framework

Migration is a social demographic that is dependent and influenced by many factors based on a countries political and economic standing. Individuals migrate to better their condition and to seek the best opportunities available. While this is the case, there are several different theories of migration that exist. This paper will follow the theory of the new economics of migration. This theory supports the idea that migration decisions are made by a larger unit of people (family) rather than an isolated individual. The new economics of migration supports the rationale that families collectively seek to diversify risk, and maximize output or income. This model is used because remittances are one of the larger parts of the Egyptian and Moroccan economy. This indicates that a significant number of individuals abroad support families in their home country which they migrated from. This theory of migration will be used to analyze the impacts of climate change on migration patterns.

The new economics of migration theory supports the idea that decision making is made by families and not by the individual. By doing this families can have several methods of risk diversification in the wake of certain extraneous events. Families can split labor by employing some labor in domestic markets, while at the same time sending individuals abroad and having family members work in foreign markets. By doing this, the family has multiple streams of revenues which diversify risk that may be present in the home country. If economic conditions in the home country deteriorate due to extraneous factors (in this paper the extraneous factor is climate change), then households can rely on migrant remittances for support (Massey et al., 1993). Developing countries do not have insurance or credit programs that minimize the risk of market failure, which leaves migration as the only option to cop with such distress. Some

examples of this are crop insurance markets, futures markets, unemployment insurance, and capital markets. Each of these examples exists in developed countries which minimize the risk of market failures. In the case of developing countries, if agricultural production is compromised due to an extraneous factor they family is not compensated for their losses. Regarding future markets, developing countries do not have the luxury to use these markets to mitigate the losses due to price fluctuations. If price falls below expected market value, the family in the developing country is faced with substantial losses that can be difficult to recover from. This goes hand in hand with unemployment insurance as well and capital markets. In developing countries, if an individual is hurt or is unable to work, income is directly affected, and their livelihood is threatened (Massey et al. 1993). In developed countries, if an individual is unable to work they are compensated through government insurance. Also, individuals in developed countries that are unable to work have the luxury to obtain capital that could increase productivity. On the bother hand, individuals in developed countries do not have the resources to maximize productivity if someone is unable to work. These examples show the lack of support that families in developing countries receive. They are not compensated for their losses, which often forces families to migrate or send family members abroad.

The new economics theory of migration accurately depicts the situation of individuals and families throughout the two countries that are being compared in this paper. Families throughout these two countries do not have the resources to overcome losses due to extraneous factors. Furthermore, the new economics theory of migration uses families as an accurate measurement for migration research instead of using the isolated individual. Also, it recognizes that wage differentials are not the only driving factor of migration as is the case in neoclassical theories. While economic development in the sending country may increase and wage

differentials are reduced or even erased, the appeal of migration often will not change. In this theory, governments have the ability to influence migration through the use of policies and economic changes. These changes can influence certain social and political demographics that can either reduce or increase the appeal of migration. The new migration theory of migration sets up the framework for the rest of the paper when analyzing the impacts of climate change on migration.

2.2: Dimensions of Migration

The effects of climate change on countries all over the world influence political and economic instability. While these changes to the world's climate may cause macro issues for countries, it is the micro issues such as migration influenced by climate change that should be analyzed in greater detail. Climate change can displace millions of individuals which would in turn possibly intensify the current refugee crisis that is present in the Middle East. Climate change is a global issue that is consistently overlooked, as its impact on specific economic and political issues are not analyzed enough. This paper will continue to analyze the effects of climate change, and its nexus to migration.

Migration is the movement of people from one place to another, usually due to extraneous circumstances. Migration is both a coping mechanism to deal with changes in climate or environmental conditions and an income diversification strategy. Migration helps improve the employment and earnings prospects of migrants, and it may also help the family at home through remittances (Wodon et al. 2014). Individuals that migrate from the home country often move as a way to improve their or their families current condition. With this being the case there are many dimensions of migration. One type of migration that exists is internal migration. Internal

migration refers to the movement of people within the home country. Those individuals who migrate internally move from town to town rather than leaving the country altogether. Regarding internal migration, rural to urban migration and rural to rural migration are the most common. In many cases, individuals move from rural to urban settings due to the lack of economic stability that comes from living in a rural environment. This transition to a more urban setting allows individuals and families to establish a more consistent and reliable form of income. In developing countries, finding a reliable source of income is hard considering a majority of the population is suffering from poverty. Moreover, these individuals who move internally often choose not to leave the country to remain close with family members. Also, those who migrate internally may also not have sufficient resources to move out the country. This leaves individuals and families limited options resulting in internal migration. This lack of sufficient resources that leave individuals "stranded" is often referred to as an immobility paradox. This paradox will be examined in greater detail in the next section as it is one of the many issues that individuals are faced within the MENA region. Another type of migration is external migration or also referred to as international migration. External migration refers to individuals moving from their home country to another country, or continent. This type of migration is often the result of individuals seeking to raise their standard of living or move to a place that provides more economic stability and opportunities. These individuals who choose to migrate externally often have the available resources to do so and are better off financially compared to others. These two dimensions of migration are the two most common within developing countries. Apart from these two forms of migration, circular migration or temporary migration is another dimension that is popular as well. Circular migration is defined as migration between an origin and destination involving more than one migration (Hugo 2013). Circular migration can be compared to seasonal migration

which involves individuals moving from a certain place due to agricultural constraints, and then moving back when conditions improve. In both cases, the individuals or families leave their place of origin and then return after an extended period. Circular migration allows for individuals to go and earn in a place where income is high, and the cost of living is high, and then return to spend in the place of origin that may be of lower income and lower cost (Hugo 2013). By doing this, the individual can maximize the purchasing power of his or her earnings. Circular migration instigates temporary movement of individuals; however, there are cases where individuals end up staying permanently in the receiving country. In this case, individuals will move to a place and establish a steady form of income and residence making the appeal of returning to the country of origin less appealing. Individuals will then seek to citizenship in the receiving country and then look to bring family there instead of returning to the country of origin. Circular migration leads to the temporary movement of people, however, in the long run, this temporary movement of people can also become permanent. These three dimensions of migration are the most common forms of movement for individuals and families that seek to improve their current condition. At the same time, these dimensions of migration are also directly influenced by climate change. As climate change intensifies, these patterns of migration will also continue to change whether it causes more people to move or causes more people to remain "stranded". Sudden onset disasters have the most immediate effect on families as these events usually call for immediate evacuation, or the aftermath of the disaster force people to move out of the effected area. Since it is apparent that climate change has a direct impact on the movement of people, the definition of a migrant and a refugee should be differentiated.

2.3: Refugee Controversy

While discussing migration and climate migrants, it is critical that the definition of a refugee is analyzed in detail. As millions of individuals are constantly moving from place to place the distinction between a migrant and a refugee must be made based on current international definitions. The definition of a refugee and a migrant will be analyzed to provide a better understanding into when analyzing the nexus between climate change and migration. Climate change continues to shape the landscape of nations economically and politically, where the definition of a refugee is considered controversial given the implications of climate change.

According to the United Nations, High Commissioner for Refugees (UNHCR) a refugee is defined as someone who is displaced from their home country due to persecution, war, or violence. These individuals are identified and protected by international law. Under international law that was established in the 1951 Refugee Convention, refugees are entitled to the safety of being returned to the dangers that those individuals have fled; access to fair and efficient asylum procedures; and are entitled to efficient measures being taken so that the basic rights of those individuals that fall into this category of refugee are met (Edwards 2016). These individuals fall under this definition of a refugee for the main reason that those who are not granted asylum in other countries and are forced to stay at home face deadly consequences. Under this criteria, according to the UNHCR at the end of 2015, there were a total of 65.3 million individuals displaced from home. Among those 65.3 million, 21.3 million were considered refugees under the international definition. Currently, there is a "refugee crisis" that is taking place in the Middle East. Since 2011, civil war throughout Syria has caused a mass international migration of individuals. These individuals migrate to places where they can seek asylum, due to the ongoing

violence that threatens the lives of civilians throughout the country. According to the UNCHR, approximately 4.8 million individuals have fled Syria, and a projected 8.7 million will be displaced in the year 2016. Most of the individuals that migrate from Syria seek asylum in European countries or Turkey since the country is straddled between Europe and Asia. Many of the migrants travel by sea, however with the dangerous conditions of traveling through the Mediterranean, many die on the journey to seek asylum. Due to the millions of individuals who are displaced and forced to migrate from Syria, this mass migration of people is indeed considered a crisis as there is simply not enough space for these individuals to go. As these individuals are displaced from Syria, countries specifically throughout Europe are continuously trying to create methods to resettle those that are fleeing.

Since only 21.3 million people were considered refugee's by international law, it is important to analyze the definition of a migrant and compare it to a refugee. According to the UNCHR, a migrant by definition is not someone who is forced to leave their home country due to the possibility of direct threat of persecution or death. These individuals that choose to move from their countries of origin leave to better their livelihood by seeking job opportunities, educational opportunities, etc. In contrast, these individuals who are considered migrants can return to their home country and are still protected by their government. The controversy that occurs is because those who are displaced by climate shocks, or environmental degradation are not considered refugees. Individuals who choose to migrate from their home country due to lack of resources or uninhabitable living conditions are not protected by international law as refugees are and are not able to seek asylum in other nations. This proves to be controversial as individuals who lack resources such as clean water and face conditions that inhibit agriculture are often forced to fend for themselves. Although aid is provided to those in need, more often

than not the most efficient and productive way to escape such economic and social hardships is to migrate from the home country. As climate change continues to intensify with the possibility of living in a 2 or 4 degree Celsius world, areas will become uninhabitable. Certain places throughout the world will be too dry to sustain life along with agriculture, while other locations will be submerged in water due to rises in sea levels. While this is the case, the argument can also be made that climate change is a factor that instigates and intensifies conflict within many regions as well. In specific areas where individuals do not have the ability to migrate, conflicts will arise due to the lack of resources within that particular area. On the other hand, individuals who choose to migrate to seek asylum can be discriminated against and can face hostility in the host country. This nexus between climate change, migration, and conflict will be analyzed in short. Although there is a connection between the three, it is hard to attribute one to the other. As mentioned before, predicting changes in the climate of the world is never a given, along with anticipating migration and conflict patterns. While the long term effects are variable, in the short run a nexus does exist between the climate change, migration, and conflict.

2.4: Vulnerability

While understanding the nexus between climate change and migration, vulnerability is something that should be measured and understood to understand the relationship between these two variables better. Vulnerability or economic vulnerability can be identified as the exposure of an economy to exogenous shocks that stems from a countries economic features including economic openness, and import and export strategies (Briguglio et al., 2008). The strength of a countries economy is a reasonable estimate of how vulnerable a country may be to exogenous factors. If a country is highly vulnerable to exogenous factors, there is a likelihood that other

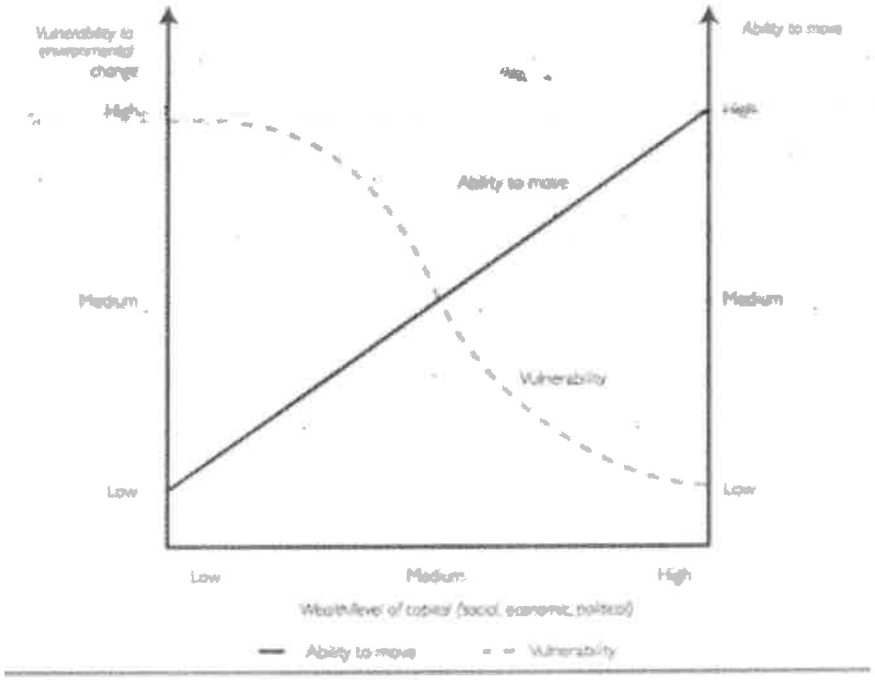
sociopolitical variables such as migration rates are influenced due to economic instability. Vulnerability plays a significant role in determining how likely and at what cost a country is impacted by negative exogenous factors.

In this paper, the exogenous factor that influences vulnerability is climate change. Climate change acts as a multiplier and intensifies vulnerabilities that developing countries may already be facing. This is especially the case in countries that face higher levels of poverty. The reason for this is that individuals and families who face poverty in developing countries rely directly on climate-sensitive sectors of the economy including agriculture. In developed countries there is a smaller percentage of the population that has to rely on climate-sensitive sectors, making the country and its people less vulnerable to climate change. Meanwhile, those who suffer from poverty in developing countries are less able to cope with the effects of climate change and at the same time are unable to rebound from the effects. Graph __ shows how wealth and capital, vulnerability to environmental change, and ability to move are related. This graph indicates that as the level of capital or wealth increases, the vulnerability to climate change decreases and the ability to migrate increases. Individuals or families with lower levels of income are most vulnerable to climate change and have limited ability to migrate. Moreover, a significant reason that countries are unable to rebound or adapt to climate change is due to limited available technology and lack of technological innovation, financial restrictions, and weak institutions. At the same time, climate change counteracts movements to reduce poverty in these developing countries and even push new groups of people into poverty. With this risk being present, climate change has its largest effects on those families and individuals who are stuck in a poverty trap or income trap. These traps are defined as economies that have obtained equilibrium at a low level of output and are unable to raise overall equilibrium without external assistance.

This translates to families and individuals who are unable to establish a higher standard of living due to limited resources and opportunities in their home country. Families who suffer from poverty often reside in drought or flood prone areas, while at the same time have limited access to resources and have questionable living arrangements. This all goes hand in hand with governments that do little to nothing to minimize the effects of climate change on these poor families and individuals. In the paper titled Social Dimensions of Climate Change written by Mearns and Norton (2010), the two individuals fully analyze the social complications that climate change presents, in both high and low-income countries. As environmental degradation continues to occur, the livelihood of individuals is more vulnerable as well, including families that already live a low quality of life. Climate change pushes these populations to a low standard of living that violates their basic human rights (Mearns and Norton, 2010). In this case, when the human rights of a population are compromised it is up to the government or the state to take the appropriate action to fulfill their human rights obligations. Climate change is an extraneous factor that amplifies the vulnerability of developing countries in ways that lead to changes in social dimensions of economies. With it being apparent that poorer families and individuals are the most at risk and or vulnerable to climate change, it is crucial to understand how vulnerability and climate change are interrelated.

Climate change not only shifts the dynamic of the environment but also has implications on the social landscape of countries as well. As climate change and environmental degradation continue to impact developing countries negatively, the social implications are astounding. The goal of this paper is to understand the nexus between climate change and specific social politics which include migration. As mentioned before, migration is considered a coping mechanism and or income diversification strategy. Since individuals and families that suffer from poverty are the

Graph 2.1: Schematic Representation of How Wealth or Capital, Correlates With Vulnerability to Environmental Change and the Ability to Move



Source: Black et al., 2011

ones that are most directly influenced by climate change and environmental degradation, they are the group of people that go hand in hand with changes in migration patterns. Sudden and slow onset events shape the environment causing problems for individuals that rely on land for shelter, and or income. When this land is compromised due to possible shifts in seal level, aridity, or even rainfall the options that poor families have remained limited. In these cases individuals are forced out of their home due to poor conditions, and or limited means of income to survive. Something that should be noted is that changes in migration habits or patterns cannot always be strictly a result of claims change. As mentioned previously, climate change amplifies the vulnerability of certain countries, however, it is these shifts in vulnerability that often influence individuals and families decisions to move or stay. Climate change heightens these

vulnerabilities which in turn ultimately play the largest role on whether a family or individual migrate.

2.5: Push and Pull Factors

Individuals or families that make the decision to migration are faced with push and pull factors. These are factors that have a direct influence on the individual's decision to migrate to another place. Pull factors are considered conditions that attract migrants or potential migrants to urban areas (Wodon et al. 2014). Countries with the existence of economic opportunities established education systems, and community networks are all factors that can be appealing to individuals who are looking to migrate. These pull factors often present opportunities for individuals to attain a higher standard of living in comparison to their home country. On the other hand, there are push factors that repel individuals from the home countries. Push factors can be conditions in the home countries that negatively affect the lives of individuals or families which make the option of migrating more appealing. Push factors can be high crime rates, disease, declining climate conditions, etc. Climate change can be classified as a push factor as declines in water availability, or extreme weather conditions are all factors that can push individuals and families out of the home country. In countries that have higher rates of poverty, agriculture is a primary source of revenue and food for many families. While this is the case, climate change that has an impact on weather patterns can negatively impact agricultural production, which can leave families with no choice but to migrate from the home area. In this paper, the Middle East and North Africa are both areas where the agricultural sector accounts for a larger portion of many countries economy. Climate change can compromise land and water availability which can reduce income for families, and reduce food availability as well making it

harder for these people to survive. The effects of climate change on agriculture will be analyzed in more depth in the sections that focus on Egypt and Morocco. Furthermore, these push and pull factors each play an important role in the decision making of families and individuals to migrate to another country that may offer better opportunities.

2.6: Immobility Paradox

This lack of resources that prevent individuals and families from migrating can also be referred to as an immobility paradox. This is the idea that to migrate, there is a minimum level of resources required by families and individuals. This refers to the ability of those choosing to migrate internationally and internally. For those looking to migrate internationally, they must have resources that include transportation, food, and money to make the migration possible. If these resources are not available, the probability of the family or the individual being able to migrate or survive the journey to the host country is unlikely. While resources are needed to travel internationally and internally, there is another problem that arises. This issue is that liquidity constraints prevent individuals and families from poorer households from moving at all (Wodon et al. 2014). Many families that belong to the poorer sector of the economy have invested their money in the land that they own making it unrealistic for them to move. This inability to move due to lack or resources of due to liquidity constraints is what creates this "immobility paradox" that is present throughout many developing countries in the world. This paradox exists in Egypt and Morocco and will be intensified by climate change. The next chapters will look at the specific dimensions of climate change in both coutures and examine the impacts on migration trends.

Chapter 3: Egypt

Now that the overall implications of climate change are understood it is necessary to analyze the specific impacts of climate change in Egypt. Egypt lies in an arid region of the world residing in Northern Africa and is surrounded by Libya and Sudan. It is the second most populous country in Africa, with a population of about 88 million (Agrawala et al. 2014). Egypt receives little rainfall and is characterized by its hot and dry temperatures. Also, Egypt's cities and most of its population are centralized around the Nile river. The Nile provides about 95 percent of the countries total water needs, and the majority of its population resides in a strip of land that accounts for less than 5 percent of the countries total area (Agrawala et al. 2014). Since the population of Egypt is heavily concentrated around the Nile River, the country is highly vulnerable to climate change. Of the dimensions of climate change that were mentioned earlier in this paper, sea level rise, extreme temperatures, and declining rainfall are the dimensions that will have the most impact on Egypt. Alongside these dimensions of climate change, the population in Egypt is also rising. This increase in the population along with the effects of climate change will all have downward pressure on the Egyptian economy. The largest impact that climate change will ultimately have on Egypt is its agricultural sector. The agricultural sector accounts for 13.7 percent of GDP and also employs more Egyptians than any other sector at 30 percent of all employment (Smith et al. 2013). Rises in sea level have the potential to destroy crops and land the surround the Nile Delta. With sea level rise increasing in the Mediterranean Sea, and the Nile Delta sinking due to the cultivation of the land, Egypt's most populous cities are considered very vulnerable. Apart from this higher temperatures make it more difficult for agriculture to develop as extreme heat can also destroy crops leaving lands incredibly arid.

Finally, declining rainfall and precipitation proves to be an issue due to water availability throughout the region. This issue of water availability will be analyzed further as it is one of the other issues throughout the MENA region.

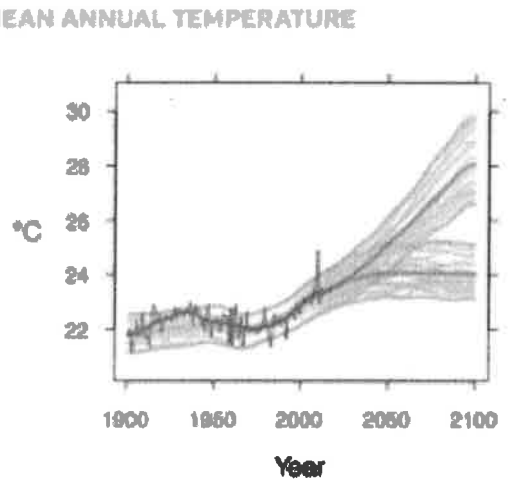
Before analyzing the dimensions of climate change that are impacting Egypt, its population dynamics must be understood. While climate change will negatively affect Egypt, its population plays just as much of a role. With the second largest population in Africa, Egypt's population is projected to grow dramatically. By 2050 the overall population of the Middle East and North Africa is expected to double, as Egypt's population is expected to grow by 1 million people every nine months (Agrawala et al. 2004). With this in mind, increases in the population will add onto the pressure that climate change has on water availability. As the number of individuals that live in Egypt increase, the amount of water and food that is available will slowly decrease in a region where more water is used than the global average. This consistent increase in the population is another variable that intensifies the effects of climate change and will be taken into account throughout the paper.

3.1: Elevated Temperatures

The MENA region is an area in the world that is subject to the most dramatic changes in climate. This region is projected to face increased temperatures; even though temperatures are already astoundingly high. It is projected that in a 2-degree Celsius world 20-40 percent of summers will have highly unusual heat extremes, and in 4-degree Celsius world, 90 percent of summers will have highly unusual heat extremes (World Bank 2014). This possibility of extreme temperatures has downward pressure on agriculture and overall health of individuals in these regions. According to the World Health Organization (WHO), the annual temperature of Egypt is

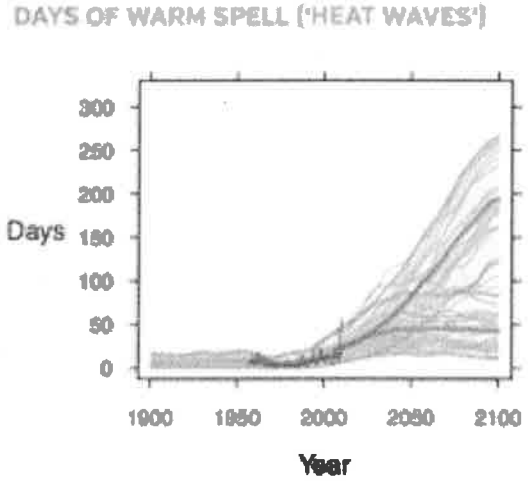
projected to rise to 5.6 degrees Celsius on average by 2100. Graphs 2.1 and 2.2[3] show that Egypt's annual temperature has been increasing steadily and is projected to increase over the course of the century. Along with this the graphs show that increased temperatures will also increase the frequency of heat waves.

Graph 2.1: Mean Annual Temperatures 1900-2100



Source: World Health Organization, 2015

Graph 2.2: Mean Annual Temperatures 1900-2100



Source: World Health Organization, 2015

As temperatures continue to increase the effects can be devastating, especially in Egypt where agriculture is a dominant sector of the economy. An overall rise in temperatures would lead to a higher evaporation rate. As water in reservoirs evaporates at a higher rate, water availability declines and the likelihood of a long-term drought are more likely to take place. With the risk of droughts increasing due to extremely high temperatures, the agricultural sector is in the most danger of facing economic decline. Egypt is prepared for a year-long drought through water

[3] The WHO uses 20 different models to project changes in temptresses and heat waves. While each model has different projections, there is an upward trend in temperatures and heat waves by each model used in these graphs.

resources from dams, however higher evaporation rates and an increased population will likely change this. Moreover, increases in temperatures will not only reduce economic output throughout Egypt but will also have adverse effects on the health of individuals. Heat-related illnesses will continue to grow affecting children and the elderly the most. These illnesses will become more common throughout Egypt due to the number of people that are unable to access clean resources such as drinking water. Overall, increases in temperatures and the frequency of heat waves will create additional complications for Egypt, which is already located in one of the hottest regions in the world. As these temperature become unbearable to the population the likelihood of migration whether it is internal or international increases.

3.2: Declines in Rainfall

Along with the other dimensions of climate change presented so far, one of the other dimensions that will have an adverse impact on Egypt is declines in rainfall. Egypt already has minimal rainfall throughout the year; however, decreases in rainfall would put pressure on resources that are already scarce. In a 2-degree Celsius world rainfall in the MENA region is projected to decrease by 20 to 40 percent and in a 4 degrees Celsius world this region would face a 60 percent decrease in rainfall (World Bank 2014). These parts of the world are already the most arid and dry and face low levels of precipitation. Further declines in rainfall and overall precipitation would prove to be devastating to a region that is reliant on the environment to produce income. The direct impact of reductions in rainfall is linked to affecting fresh water supplies and groundwater. Lack of freshwater can result in declines in public health which translate to an increase in the risk of contracting an infectious disease (UNDP 2011). Also, decreases in rainfall can lower agriculture production as land becomes less fertile due to aridity.

While this is the case, Egypt is not reliant on rainfall for agricultural production as most of the water used is irrigated from the Nile. Declines in rainfall however can have a direct impact on growing seasons. This in turn can impact overall agricultural production as declines in rainfall can shorten growing seasons. Although this dimension of climate change is difficult to project, the possible variations in rainfall are unlikely to have an dramatic effects on migration in the short turn. Rainfall variability is likely to intensify other issues in the long term such as droughts that will increase migration patterns in the future.

3.3: Rising Sea Level

Of the dimensions of climate change that were presented earlier in this paper, sea level rise will have the most significant impacts on Egypt. While sea level rise is below the projected global average for the MENA region, rises in sea level in Egypt are expected to have significant impacts due to the portion of the population that lives off and relies on the Nile River. In 2007 the Intergovernmental Panel on Climate Change (IPCC) named the Nile River and its deltas one of three sites in the world that will be drastically affected by sea level rise. The Nile River is the primary source of water for a majority of the population which leaves many families vulnerable to rises in sea level. Egypt is in the conversation as a top ten country to be impacted due to sea level rise where sea level rise is expected to be between .19 and .58 meters by 2100 relative to rises in sea level between 1980 to 1999 (Piontek et al. 2015). Table 2.1[4] shows the potential that sea level rise can have on the population between 2070 and 2100. With certain adaptation and mitigation methods, the amount of individuals that are exposed to rises in sea level can be

[4] RCP2.6 represents a low emissions scenario while RCP8.5 represents a high emissions scenario. The table shows the individuals exposed to sea level without adaptation and with adaptation (i.e.construction and raising of dikes)

limited. However, if Egypt is unable to adapt the amount of individuals that are exposed is greater than two million.

Table 2.1: Exposure to Flooding Due to Sea Level Rise

EXPOSURE TO FLOODING DUE TO SEA-LEVEL RISE

Severity of climate change scenario		Without Adaptation	With Adaptation
	RCP2.6	566,200	700
	RCP8.5	2,420,600	1,500

* Medium ice melting scenario ** Values rounded to nearest 10

Source: WHO, Climate and Country Profile: Egypt 2015

These increases in sea level expose and effect millions of individuals while at the same time making the coastal regions of Egypt even more vulnerable.

The coast of Egypt is a popular tourist destination and extends for over 3500 km in length along the Mediterranean and Red Sea (Elsharkawy et al. 2009). The coastal zones of Egypt are crucial to its development as access to natural resources, and its popularity makes it a focal point of its economy. About 15 percent of the Egyptian population reside in the coastal zone, while the rest of the population is located mainly along the Nile river. Although this is the case, the coast of Egypt is vulnerable to particular dimensions of climate change that include coastal erosion, seawater intrusion, salinization of water and soil, and Nile Delta inundation (UNDP 2011). This vulnerability of the coast is attributed to the creation of the Aswan dam and the cultivation of land along the Nile and coastal regions. The Aswan dam was built for irrigation and transportation purposes; however, attributes to land erosion and the intrusion of salt water into the Nile and its deltas. The coast of Egypt will suffer from soil erosion and will continue to cause

the land to retreat. As coastal erosion takes place the tourism sector of the economy will deteriorate as it is a large part of the Egyptian economy. Soil erosion will also lead to increased salinization levels. As salt water intrudes the Nile river and its deltas the land will absorb the salt within the water. If the land continues to absorb high levels of salt, it will become uncultivable leading to a decline in agricultural production. Alongside these effects of climate change, sea level rise would result in possible flooding events that pollute water supplies, which would possibly increase the risk of contracting infectious diseases. Flooding would have adverse effects on human health as the risk of disease in an underdeveloped country as Egypt would increase. Flooding would also lead to the destruction of cropland leaving individuals helpless and jobless. Destruction of cropland and homes due to flooding would instigate migration to areas that are above sea level and are not at risk for flooding. These are the overall impacts that sea level rise would have on Egypt if preventative actions are not taken to reduce global warming, or adaptation to sea level rise is non-existent. As sea level rise increases, internal and international migration trends will likely shift.

3.4: Water Resources and Availability

From the three mentioned dimensions of climate change, each will have a negative impact on water availability throughout Egypt. Egypt's economy is very water reliant and almost the entire population relies on water from the Nile River. According to the IPCC, Egypt and Libya are the only two countries in Africa that consume more than 90 percent of its available water. Egypt's water resources stem from the Nile River, and Egypt is allocated 55.5 billion cubic meters of water according to the Nile Basin Treaty of 1959 (Smith et al. 2013). The water from the Nile and other resources do not fulfill the needs of Egypt as the country consumes about

63 billion cubic meters of water annually. Egypt uses more water than available due to the reuse of irrigation drainage water. While this reuse of water seems innovative for a country who suffers water shortages, filtration problems and human error can lead to water that has remnants of fertilizer, and pesticides. The reuse of water is innovative; however, it leads to water supplies being of a lower quality. This is the current situation of water availability throughout Egypt without taking climate change into account. Climate change will intensify these pressures on water and will reduce the overall availability of water within the country in the future.

One of the major issues that come along with higher temperatures is higher evaporation rates. Egypt is a country that receives little rainfall, and the issue that occurs is when evaporations rates are greater than rainfall rates. At this point, lakes and reservoirs that provide small towns and villages with access to water will eventually dry up. Drying of lakes and reservoirs will lead to droughts that last for extended periods of time creating substantial losses in the agricultural sector while still increasing the demand for water. This water shortage along with higher demand due to climate change has political repercussions as well. The Nile River is divided between the states that surround it (Egypt and Sudan claim most of the Nile's waters). The Nile Basin Treaty of 1959 states that average annual flow will be split between Sudan and Egypt while the countries that contribute to the Nile's flow are not entitled to any resources. As water availability continues to be an issue in the MENA region, countries that contribute to the majority of the Nile's water will demand more water, creating political tension and conflict. Furthermore, water availability in Egypt is one of the areas that is a great cause for concern. An increasing population to go along with higher temperatures will dwindle the water supply in Egypt creating many political, economic, and social issues. Increased water demand and access to clean resources continues to be an issue throughout Egypt, which impact overall health and

will cause more individuals to use migration (internal or international) as a coping methods. Water availability is connected to agriculture, and the effects of climate change on agriculture will be examined in the upcoming section.

3.5: Agriculture Production

The World Bank in its report Turn Down The Heat (2014), projects the effects of overall climate change in the MENA region. One of the results of climate change on agriculture will be the northward shift of agricultural zones. Along with this, the World Bank projects that the length of the growing period will also shorten due to increases in temperature. Higher temperatures and lower levels of rainfall will attribute to growing periods reducing by two weeks by mid-century. As growing periods continue to shorten, agricultural production will decline as well. Crop yields are projected to decline by 30 percent in a 1.5 to 2-degree Celsius world, and by 60 percent in a 4-degree Celsius world without considering for adaptation (World Bank 2014). The final effect that the climate change will have on agriculture is livestock. As temperatures increase, and water availability decreases overall livestock health will decline. The risk of dehydration and other diseases will also increase as water quality, and overall conditions will decline. The effects of a warmer climate can have devastating effects on countries that rely so heavily on agriculture to sustain economic development. While these figures and projections cover the entire MENA region, the effects of climate change on agriculture in Egypt are very similar.

All the dimensions of climate change that were mentioned earlier in this chapter are linked to agriculture in Egypt. Agriculture is the one sector of Egypt that is the most vulnerable and will be the most impacted. As mentioned before, the agricultural sector in Egypt accounts for 13.7 percent of GDP and engages about 55 percent of the labor force. In Egypt, land dedicated to

agriculture has increased throughout the years. In 1980 cropped areas stood at 11.1 million feddans[5], and rose to 15.2 million feddans by 2007 (Smith et al. 2013). This increase in cropland, however, was also coupled with an increase in employment across the country as well. Over the same period, the number of individuals employed in agriculture also increased. This led to the average farm size per capita to decrease drastically. In 1950 average farm holdings were at 6.3 feddans in comparison to 2.1 feddans in 2013, with the number of individuals farming with one feddan or less at 43 percent (Smith et al. 2013). This transition from larger farms to smaller farms throughout Egypt has made the agricultural sector more vulnerable to climate change. Smith et al. (2013) report that larger farms which are more capital oriented are better suited to adapt to climate change. On the contrary, smaller farms do not have the resources or the time to be able to cope with environmental changes. The agricultural landscape of Egypt has indeed evolved over the decades and will continue to change as the effects of climate change come to a realization.

As mentioned before Egypt's climate is set to warm on average by about 5.6 degrees Celsius by 2100 and the effects on the agricultural sector fall in line with the projections that the World Bank (2014) makes. Increases in temperatures will indeed lead to lower crop yields and shorter growing periods. In the report by Smith et al. (2013), a climate change model[6] is used to project the effects of climate change on agricultural production. The model shifts its variables and gives agricultural projections in the years 2030 and 2060. The projections made by Smith et

[5] Feddan is a unit of area that is used in the Egypt, Sudan, Syria and the Sultanate of Oman. One feddan is equivalent to 0.42 hectares or 1.038 acres.

[6] The model used by Smith (2013) makes projections based on variables such as a certain rise in sea level, population, import and exports, Nile River flow, etc. These variables were shifted to resemble possible changes in climate in 2030 and 2060 to create projections for agricultural production in each year as well. The model also shows the projections from a pessimistic and optimistic standpoint.

al.(2013) show that the crop yield of individual crops will decrease in both 2030 and 2060. The two primary crops that will be negatively affected are wheat and maize. Smith et al. (2013) show that wheat yield will decline by 9 percent by 2030, and by about 19 percent by 2060 under various circumstances. Maize yields, on the other hand, will drop by 8.4 percent by 2030 and by about 15 percent by 2060. Another study done by United Nations Framework on Climate Change (UNFCC) titled Egypt Second National Convention projects that maize and wheat will decrease by 15 percent and 19 percent respectively by 2050. While both studies give projections that are relatively similar, it is hard to project crop yields due to the uncertainty of the climate. At the same time, the trend of increasing temperatures in Egypt will likely lead to a decrease in agricultural production. These projections by Smith et al. (2013) also show that crops will need twice as much water to grow in 2060 than 2030. The amount of water required for strong maize growth in 2030 would increase by 3.3 percent, and 6.6 percent in 2060. On the other hand, wheat would need a 3.6 percent water increase for successful growth in 2030 and 7.2 percent in 2060. The UNFCC projects that water requirements for crops will increase from a range of 6 percent to 16 percent by 2100. As temperatures get higher and land becomes drier, crops will need more water to survive and grow efficiently. As crop yields decline over the years, production and consumption of goods from agriculture will decrease while food prices increase. As production decreases, the demand for goods will push the price up of goods up. Higher prices in a developing country thus lead to lower consumption rates as individuals and families are unable to afford the goods they once could. These lower consumption rates can result in a decline in overall GDP, leaving Egypt no room for economic growth. These projections show that the agricultural sector of Egypt will stagnate and output will decrease as climate change gets worse and worse. Apart from production and output, climate change (specifically rises in sea level) will

also destroy farmland. Possible inundation of the Nile River and its deltas can lead to the destruction of thousands of farms. Going hand in hand with this is the rise of salinity levels in the land as well due to the possibility of sea water intrusion into the Nile and its deltas. As salinity increases, the land loses its fertility and becomes uninhabitable. According to the IPCC salinization will continue to increase to the point that by 2100, 60 percent of the land throughout Egypt will become so saturated by salt that it will not be farmable. Sea level rise has and will have indirect and direct implications on crop productivity, and overall agricultural output throughout Egypt in the future. These effects of climate change on the agricultural sector of Egypt are linked right to shifts in the political, economic, and social landscape of Egypt. Shifts in agriculture due to climate change will be the largest driver of environmental migrants throughout Egypt in the future. Egypt is a prime example of how climate change influences migration patterns. The economy relies heavily on its agricultural sector, and its population is centered around its one main source of water. This creates situations where rises in sea level, increased temperatures, and declines in rainfall can all influence a families or individuals decision to migrate. The next section will put together the overall impact that climate change can have on migration patterns throughout Egypt.

Changes in the climate in this region will have negative short-term, and long-term effects as the impact on agriculture are substantial. As the agricultural sector and other sectors of the Egyptian economy continue to deteriorate due to climate change, migration patterns are likely to shift as well. As individuals are unable to sustain a stable lifestyle, the chances of migrating to another area in the country or another country increase dramatically. As mentioned before migration is a coping mechanism that is used to diversify income, and to mitigate the impacts of climate change. This next section will go on to analyze internal migration and international

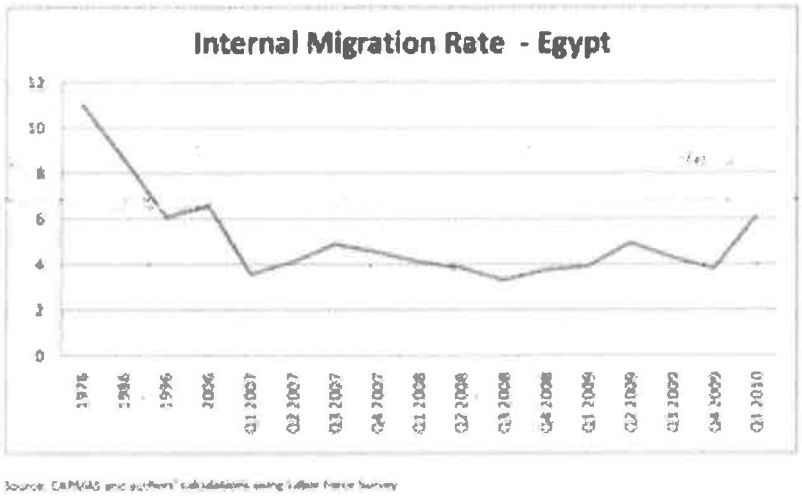
migration patterns throughout Egypt. Migration statistics will be used to see the change in the number of migrants that are leaving and coming to Egypt.

3.6: Internal Migration

Internal migration is one of the few methods that individuals and families can utilize to resolve current economic issues. It is one way for individuals and families to diversify income while at the same time retaining family ties and land. One of the most common directions of migration throughout Egypt is from the South to the North of Egypt. Other migration patterns include south to north to the canal zone and Egypt's hinterland to major cities (Zohry 2005). These three trends are the main historical internal migration patterns throughout Egypt and accurately depict the movement of people throughout the country. These directions of migration are linked directly to changes in the climate as Egypt's migration, and population revolves around the Nile river. This section will analyze the direction in which individuals and family in Egypt migrate and how possible climate change scenarios in the future are likely to change these patterns.

Before examining the nexus between directional migration in Egypt, it should be noted that internal migration rates have been declining in recent years. According to the World Bank, internal migration rates throughout Egypt have been declining and are below international standards. International standards for internal migration are at 15 percent, while Egypt's internal migration rates are at 8 percent (Herrera 2012). In graph 2.2, the rate of internal migration is shown every year the census is taken and then quarterly from 2007 onward till 2010. The graph shows a downward trend for internal migration where the rate stands between 4 and 6 percent between 2007 and 2010. In the short term, it is hard to attribute these low levels of internal

Graph 2.3: Internal Migration Rate in Egypt 1976-2010



Source: Herrera et al., 2012

migration to changes in climate change. While changes in climate may have had an impact, the internal migration rate is more likely to decline in the future once more dramatic changes in Egypt's climate occur. Otherwise, this decline in internal migration can be attributed to low educational attainment, declined agricultural production, and food production for consumption (Herrera 2012). Educational attainment has been linked to migration rates, as those with a higher educational attainment are more likely to migrate. Internal migration rates are decreasing likely due to an increase in the number of individuals with a low level of education, along with an increased rate at which individuals with a higher level of education are migrating. Another aspect that plays a role in the declining rate of internal migration is agricultural involvement. Throughout Egypt and other developing countries, agriculture goes hand in hand with low wages, and a lower standard of living. Often individuals are tied to the land that they own and use for agriculture decreases the appeal to migrate to other governorates. Also, individuals who live off agriculture are often not qualified for other jobs as well reducing the motivation to migrate. Finally, food production for consumption also plays a role in the declining rate of

internal migration. Individuals who produce their food can stay away from buying high priced foods due to inflation. Individuals and families who can avoid buying high-priced foods, and increase their opportunity cost by producing their food are unlikely to migrate. A significant portion of the Egyptian population grows its own food, decreasing the appeal of migrating to areas where food prices are higher. Furthermore, declines in internal migration rates can be attributed to changes in these short-term demographics. However, in the long-term, climate change is likely to decrease the rate of internal migration due to its effects on agriculture. As shifts in the Nile take place, more individuals will be forced out of the country rather than moving to urban settings where population density continues to increase.

The first trend of migration that should be analyzed is the migration of people from the South of Egypt to the North of Egypt. This moment can also be described as rural to urban migration. As land becomes less cultivatable and water availability is more variable, individuals and families move to more urban settings to minimize the risk of unemployment. Those individuals who are considered the "south" are individuals coming more from middle and upper Egypt. Populations density throughout the region is heavily concentrated around the Nile river which makes the most southern parts of Egypt uninhabitable due to lack of resources. For this reason, the South of Egypt reflects those individuals who are south of the Nile river. The governorates that are responsible for migration from the north to the south include Fayoum, Menia, Beni-Sueif, Assiut, Souhag, Qena, Luxor, and Aswan (Zohry 2005). Of these regions Qena, Aswan, and Souhag are the main contributors of migration to the North. In these regions, the main attributor to migration is the inability of agriculture to expand horizontally. As the population density within these regions increases, there is limited fertile land available for individuals and families to pursue agriculture. As land becomes more arid and dry, the area of

cultivatable land will continue to recede, pushing individuals to the North of Egypt. Alongside this, these individuals in the South and North of Egypt also migrate to canal zones. This canal zone can be identified as the Suez canal along with Port Said. The canal and ports generate a significant amount of Egyptian GDP and are one of the main reasons that individuals move towards this area. Employment opportunities in the canal zone often outweigh the risk of waiting for agriculture dividends to pay out. Those who struggle to sustain a living off agriculture move to this zone to find a sustainable form of employment. Moreover, the final direction or trend of migration throughout Egypt is the movement of people to Cairo and Alexandria. These are the two largest urban settings in Egypt and are responsible for a large portion of Egyptian GDP. These are one of the primary destinations for those individuals in the South and those living in the Delta regions of the Nile. The movement to these two cities is a majority of the rural to urban migration that occurs in Egypt. Urban areas and cities are crucial to economic development throughout the region and offer more immediate forms of employment. Along with this urban areas have more access to resources, making living in an urban setting more appealing than a rural setting. The following table shows the change in migration patterns from every year the census was taken in Egypt. From table 2.2, it is apparent that urban to urban migration is the most popular, with rural to urban migration being the next most popular type of migration. Every year that the census was take in Egypt from 1976 to 1996, urban to urban migration accounted for over 60 percent of all migrants. On the other hand, rural to urban migration accounted for an average of 15 percent of all migration from 1976 till 1996.

Table 2.2: Urban/Rural Migration by Type of Movement, Egypt 1976-1996

Urban/Rural Migration by Type of Movement, Egypt, 1976–1996*

	Census Year		
	1976	1986	1996
Urban–Urban	2,577,959 (64.3%)	3,003,054 (72.9%)	2,535,864 (60.4%)
Rural–Urban	984,469 (24.6%)	540,933 (13.1%)	562,471 (13.4%)
Urban–Rural	260,295 (6.5%)	422,955 (10.3%)	949,489 (22.6%)
Rural–Rural	186,724 (4.7%)	152,296 (3.7%)	147,611 (3.5%)
Total	4,009,447 (100%)	4,119,238 (100%)	4,195,435 (100%)

Source: Calculated from the 1976, 1986, and 1996 census data (CAPMAS 1979, 1989 and 1999)

Source: Zohry, 2005

Urban to urban migration is the most popular due to migration from Alexandria to Cairo and vice versa. In Egypt, there are four governorates that are considered entirely urban which are Cairo, Alexandria, Port Said, and Suez (Zohry 2005). High-skill individuals who have access to resources can easily finance the move to another city. At the same time, low skilled individuals are likely to move from city to city looking for job opportunities that are not available in other cities. On the other hand, the individuals who are moving from rural to urban settings are more likely to be low skilled individuals. These low skilled individuals move to an urban setting due to more economic opportunities and access to resources. Most of the internal displacement can be accounted by low skill workers who lose their jobs or are unable to farm due to extraneous conditions. Such extraneous conditions such as climate change can cause the displacement of thousands of individuals and families. As mentioned before, low skill workers are the most

vulnerable to climate change and are the first ones that are likely to be displaced by sudden and slow onset disasters. The next paragraph will assess the impact of climate change in Egypt and its effect on overall migration patterns. As climate change in Egypt takes place, it is crucial to understand how migration trends such as direction and migration type are affected.

As mentioned before the short-term impacts of climate change do not have a significant impact on migration patterns, specifically internal migration patterns. On the other hand, the long-term effects of climate change are more likely to have a more significant impact on migration trends. In the short term, sudden onset disasters are the events that are most likely to shift internal migration patterns. These disasters include floods and storms have the ability to displace individuals more immediately than slow onset disasters. Over the last three decades from 1972 to 2002, the frequency and the severity of these storms have increased, along with longer periods of extreme heat (EEAA 2010). Apart from this, rises in sea level will have the most dramatic impact on migration trends. According to El-Raey et al. (1999) sea level rise has the biggest potential to displace individuals and family throughout Egypt. Inundation is one of the major issues that sea level rises pose as governorates near the Nile and coast lie below sea level. While Egypt has adopted measures to protect these areas from inundation and flooding, rises in sea level will ultimately lead to sectors of the economy that will be negatively affected by inundation. El-Raey et al. (1999) use the city of Alexandria to show the effects that sea-level rise will have on the city. Alexandria is the second largest city in Egypt, and over 40 percent of the industrial sector is located there (El-Raey et al. 1999). In table 2.3 provided by El-Raey et al. (1999), it shows that 45 percent of the population (in 1999, as the number is likely to be higher now) resides below sea level. Along with this, 40 percent of the agricultural, wetland, industrial, and services sectors each lie below sea level. Table 2.4 provided by El-Raey et al. (1999) show

that a .5 meter rise in sea level leaves over 50 percent of some sectors of the economy inundated. In another table, El-Raey et al. (1999) project the impacts of sea level rise on critical sectors in Alexandria and the amount of area that would be lost due to sea level rise. A 30-centimeter increase in sea level by 2050 is projected to cause a loss of 31.7 square kilometers. At this rate by 2050, about 1.5 million individuals would be displaced, over 195,000 jobs would be lost, and up to 35 billion dollars would be lost.

Table 2.3: Percentages of the Population and the areas of different land use that reside below sea level (0.0 m) in

Sector	SL = 0.0 m	SLR (m)		
		0.25	0.5	1.0
Population	45	60	67	70
Beaches	1.3	11	47.8	64
Residential	28.2	27.5	39.3	52
Industrial	53.9	50.1	65.9	72.2
Services	45.1	55.2	75.9	82.2
Tourism	28	31	40	62
Restricted area	20	21	25	27
Urban	38	44	56	67
Vegetation	55	59	63	75
Wetland	47	49	58	98
Bare soil	15	24	29	31

Source: El-Raey et al., 1999

Table 2.4:Population displaced, area loss, and loss of unemployment in each sector due to different SLR scenarios (2010-2050) in Alexandria

	SLR (cm)		
	18 (2010)	30 (2025)	50 (2050)
Area loss (km^2)	11.4	19.0	31.7
Population displaced (×1000)	252	545	1512
Loss of employment			
Agriculture	1370	3205	8812
Tourism	5737	12323	33919
Industry	24400	54936	151200
Total loss of employment	32507	70465	195443

Source: El-Raey et al., 1999

These tables show that the agricultural and industrial sectors are likely to suffer the most substantial losses meaning that mostly low-skilled workers are the ones that will be displaced by sea level rise. It is apparent that climate change will displace individuals in the future; however, it is difficult to project whether internal migration or international migration are likely to increase. As people are forced to leave their homeland, the chances are that in the short term individuals will seek refugee internally. However, if land is lost, then individuals are likely unable to return home resulting in higher levels of international migration. The next section will

go over international migration patterns in Egypt and analyze the nexus between international migration and climate change.

3.7: International Migration

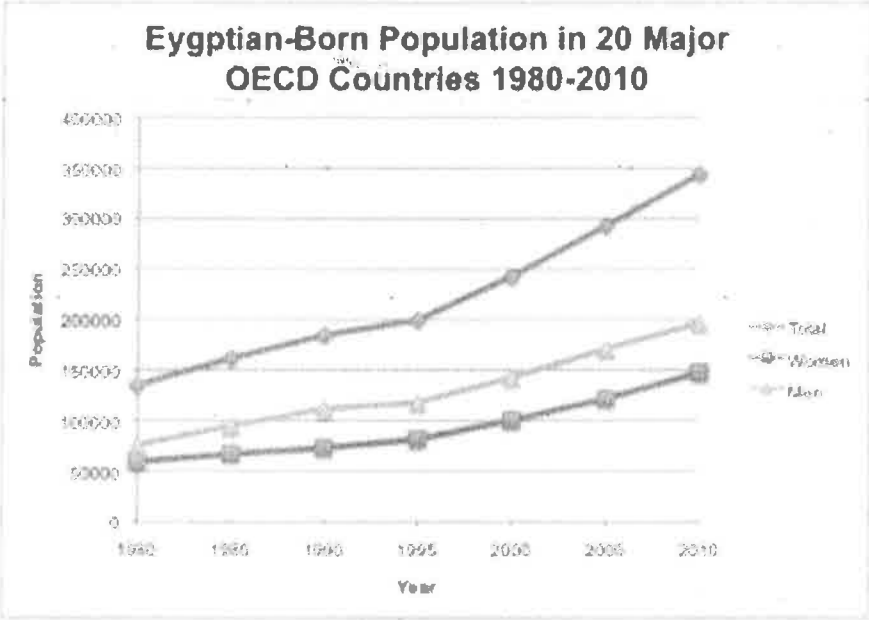
While internal migration is appealing to those individuals that would like to remain close to family, it is an option for those who do not have the resources to go elsewhere. Families on the other hand whose finances are in better shape have the choice to move internationally. International migration has many dimensions that should be analyzed as it is a popular method of income diversification. Labor has been the driving factor of international migration throughout Egypt for many decades. The lack of job opportunities and other extraneous factors such as war have increased the propensity of international migration. It was in 1967 that migration restrictions were eased, and more freedom was given to labor migrants. However, this is the same time that a "brain drain" phenomenon started to take place, as many highly educated students stayed abroad due to unfavorable economic conditions at the time (Zohry 2005). It was in 1971 that Egypt had lifted restrictions on migration allowing both permanent and temporary migration. Previously, Egypt was not a country that was known for its emigration but for the number of immigrants that would come to Egypt. However, throughout the last century, Egypt has become a country that utilizes emigration as a way to stabilize its economy. Temporary migration has become an income diversification tool used by individuals that are unable to find domestic work. Due to the emergence of the oil industry in the past century, labor migration or temporary migration has continually increased. While this is the case, it came at the expense of the Arab-Israeli war which had displaced 750,000 people. The war is an example of an extraneous factor that caused the displacement of many individuals. This war goes hand in hand

with a sudden onset climate event as it displaced thousands of individuals in very little time. Although the war displaced thousands, the oil embargo that followed increased migration rates dramatically. The embargo against the United States and its allies raised oil prices and increased the demand for Egyptian labor. The number of emigrants rose from 70,000 emigrants in 1970 to 1.4 million by 1976 (Zohry 2005). The Egyptian government supported labor migration to supply Arab countries with labor and relieve economic and political pressure. While emigration increased throughout the 70's and mid 80's, international migration somewhat deteriorated soon after due to political unrest and war. It was in the past decade that international migration rates continued to increase.

International migration in Egypt can be split into two different sections, which are permeant migration and temporary migration. The difference between the two plays a significant role in understanding how climate change impacts international migration. Temporary migration or circular migration is a popular tool that used throughout Egypt due to the opportunities that are available in neighboring countries. By 2013 there were an estimated 4.3 million Egyptians abroad, where 86 percent resided in Arab countries (Bel-Air 2016). Of the individuals that migrate to Arab countries, most if not the majority of the migrants are men. At least 90 percent of temporary migration to Arab countries with booming oil industries since 1970 have consisted of men (Zohry 2005). This may be the case due to jobs in construction and the oil industry, and also to the lack of equality between men and women in the MENA region. Gender equality is an ongoing issue that makes it difficult for women to go abroad and find jobs. In many cases, women are not allowed to work certain jobs or are considered "unfit" resulting in the extremely high percentage of labor migrants that are men. Arab countries provide job opportunities to Egyptians that residents of the host country are untrained for or unwilling to do. Low-skilled

workers from Egypt are willing to take these "unwanted" jobs as the economic opportunity may not be present in Egypt. Although temporary migration is an attractive option for individuals that are seeking job opportunities, Egypt is currently facing an issue called the "permanence of temporary migration". This phenomenon addresses the continuous brain drain that is occurring in Egypt and includes the increasing number of individuals that temporarily migrate to another country and end up staying permanently. In recent years more and more people are staying in the countries that they temporarily migrated to. Individuals who are labor migrants will migrate to select countries and decide to stay there due to better economic conditions, or a higher quality of life. This phenomenon is one of the main reasons that brain drain in Egypt continues to increase along with overall international migration. High skilled individuals in Egypt see the impact that agriculture has on the economy and will migrate internationally. One of the largest issues with this is that high-skilled individuals with high levels of education are migrating when they are needed most. High skilled workers are the ones that are needed most to solve the economic and political problems that Egypt may produce. Data provided by Institute for Employment Research (IAB) shown in graph 2.4 shows the number of migrants that reside in 20 OECD countries from 1980 to 2010. From this graph, it is apparent that international migration is indeed increasing specifically to countries that more economically stable. It should be noted that the number of

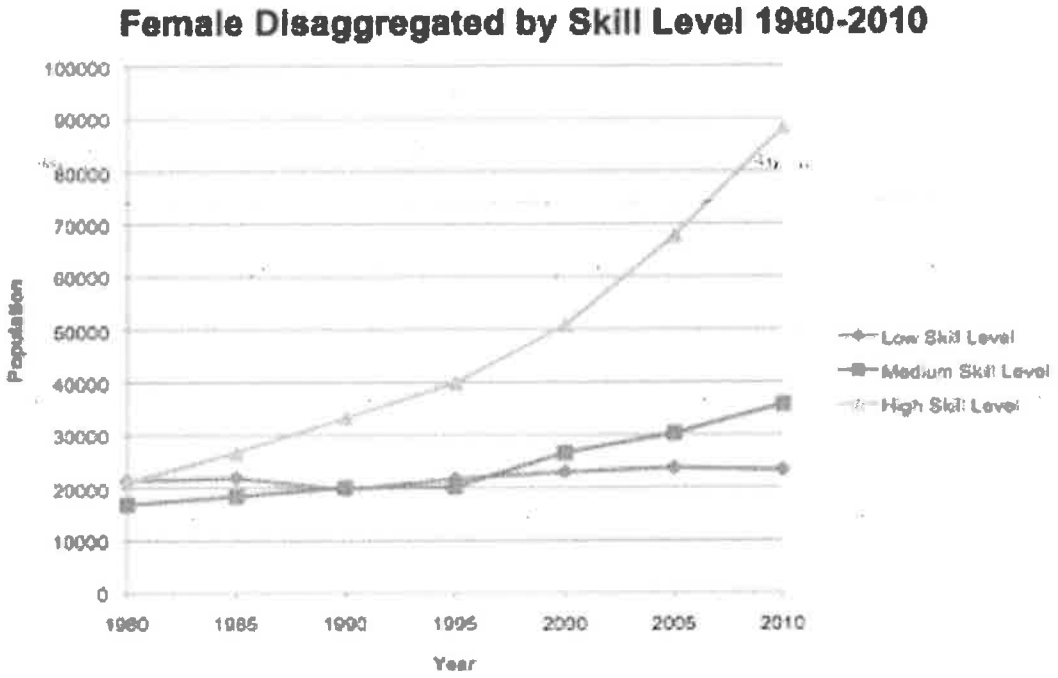
Graph 2.4: Egyptian Born Population in 20 Major OECD Countries 1980-2010



Source: Own Calculation based on IAB Brain Drain Data, 2013

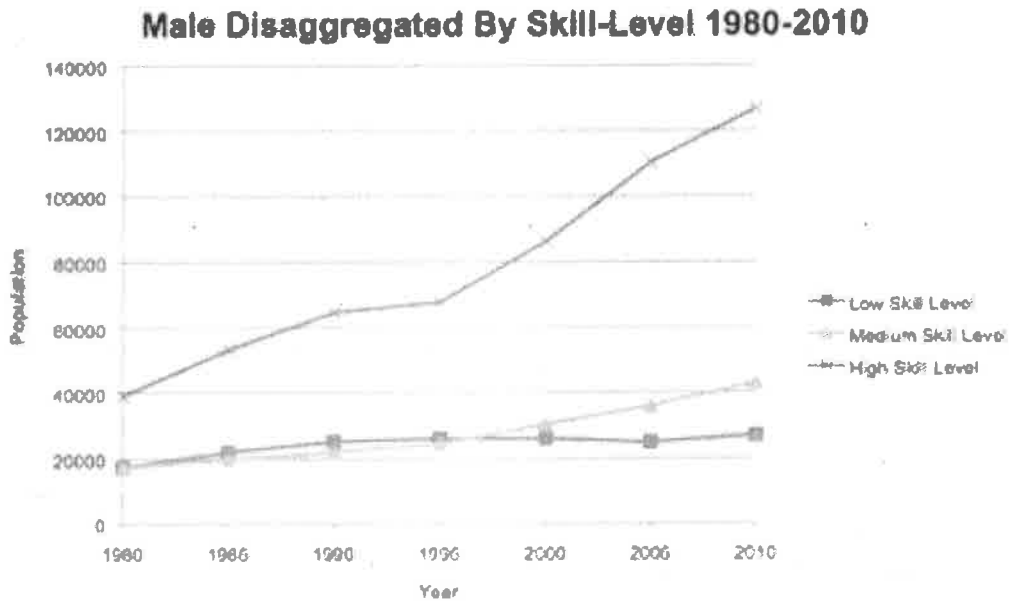
migrants is not as high as expected. This is because Arab countries are not OECD countries. The majority of migrants from Egypt migrate to these Arab countries where job opportunities are higher for low-skilled workers than in Europe or North America. Moreover, from 1980 onward the number Egyptian-born of men and women has continuously increased reaching over 400,000 migrants by 2010. Graph 2.5 and 2.6 show that brain drain throughout Egypt is indeed increasing. The number of Egyptian-born high skilled men and women continue to increase in 20 OECD countries. The number of high-skilled Egyptian-born men rose from 53,000 in 1980 to over 120,000 by 2010. At the same time the number of high-skilled Egyptian-born females rose from about 28,000 in 1980 to about 90,000 by 2010. Brain drain is one of the reasons that

Graph 2.5: Female Egyptian Born Population in 20 Major OECD Countries 1980-2010 Disaggregated by Skill Level



Source: Own Calculation based on IAB Brain Drain Data, 2013

Graph 2.5: Male Egyptian Born Population in 20 Major OECD Countries 1980-2010 Disaggregated by Skill Level



Source: Own Calculation based on IAB Brain Drain Data, 2013

international migration rates continues to increase and will continue to rise as climate change takes effect. As mentioned earlier, as domestic conditions continue to get worse, those with the resources and education to migrate internationally will do so. The next section will go over the impact that climate change could have on international migration in the future.

Before diving into the nexus between international migration and climate change, it should be noted that climate change may not necessarily increase international migration. Changes in the climate can intensify already existing demographic, social, economic, and political drivers of migration which can lead to higher international migration. However, at some point individuals that are faced with environmental degradation will not be able to migrate out of the country due to lack of resources. Egypt is still a developing country where poverty and unemployment rates are relatively higher than the world average. While the number of low-skilled individuals that can migrate will remain low, the number of high-skilled migrants will increase. As Egypt continues to become less safe due to changes in the climate individuals despite their skill level will permanently migrate internationally. As mentioned previously, internal migration is more likely in the short term when sudden onset disasters take place. As the frequency of these disasters increases in the future, those individuals who migrated internally will likely migrate internationally due to consistent displacement. Also, in the long term international migration is more likely because slow onset climate change will make Egypt uninhabitable. As certain parts of Egypt become uncultivable, and uninhabitable individuals will seek to migrate to countries that have a more consistent and reliable climate. Sea level rise in Egypt will push individuals into the middle of the country and to more urban settings. However, already high population densities in urban settings will create more displacement due to strains on resources. Water availability due to increased population density in these urban areas will

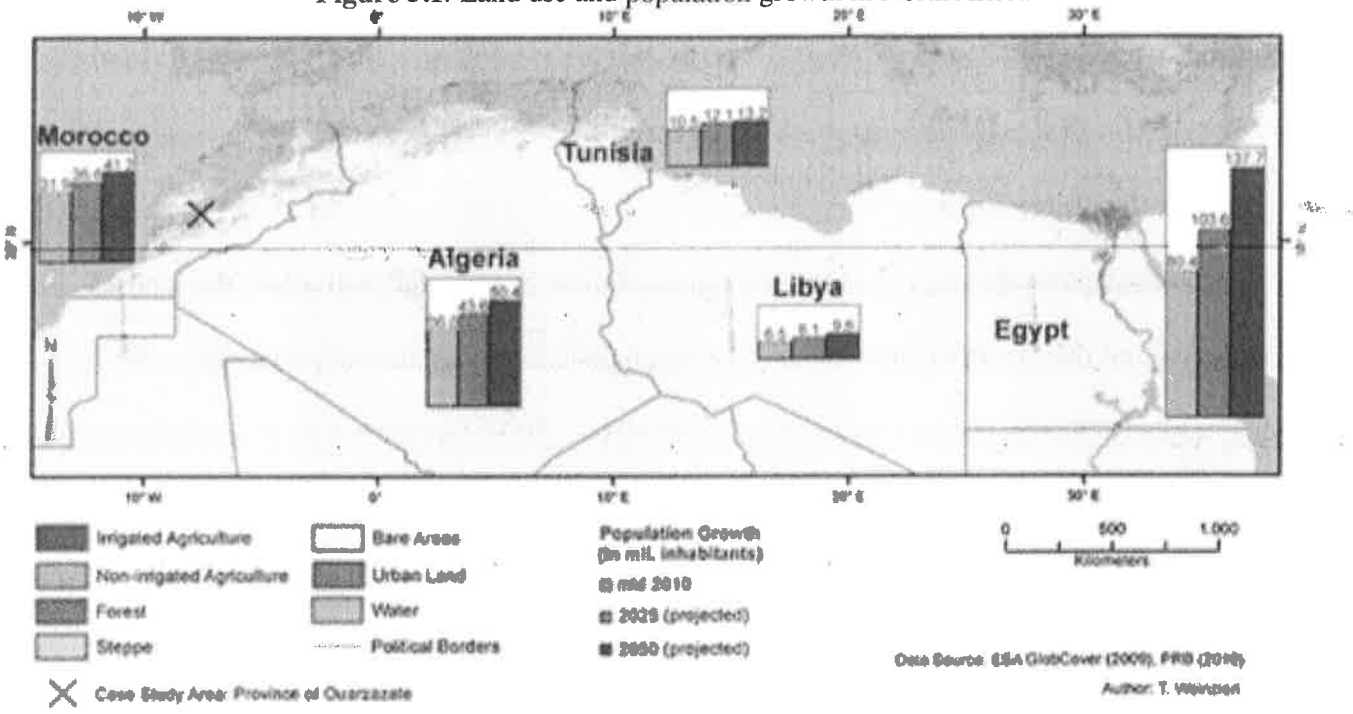
decrease causing more individuals to migrate. The issue is that even with support and aid, it will become unfeasible to provide enough drinking water and water for agriculture for a country that is seeing an increase in its population ever year. Diminishing resources due to climate change attributes to the rise of illegal international migration. As mentioned in an earlier chapter, individuals that are displaced by the environment are not considered refugees. In the case of Egypt where sea level rise is likely to displace thousands, it is hard to imagine where individuals will go when their homes are destroyed, or they land is inundated. El-Raey et al. (1999) is able to show in table 2.4, the amount of land that will be lost and the amount of the population that will be displaced due to certain scenarios. As parts of Egypt become uninhabitable and internal migration is unfeasible, individuals will turn to illegal measures to guarantee their own wellbeing along with their families wellbeing. Illegal migration to Europe is continuing to become a popular alternative for those that are unable to sustain a stable lifestyle in Egypt. As agriculture becomes less productive and individuals and families are unable to support themselves, the appeal of migration to Europe through illegal means increases. In the past decade, individuals from Egypt traveling by means of the Mediterranean Sea has increased, along with the number of individuals killed. The trip to Europe through the Mediterranean is a harsh and deadly journey due to lack of safety measures on ships, and the risk of disease and infection due to unsanitary living spaces on ships. While the risks to travel to Europe are high, individuals are willing to take on those risks since they outweigh staying in Egypt. As employment becomes more difficult to find and certain areas become uninhabitable, the number of individuals that migrate illegally will continue to increase. International migration is an effective way to mitigate the effects of climate change, it is an option that is only available for a handful of individuals. International migration

due to environmental degradation will continue to increase, as the climate of Egypt is subject to significant rises in sea level, and elevated temperatures.

Chapter 4: Morocco

The specific dimensions of climate change in Morocco are very similar to those that will affect Egypt. Morocco lies in Northern Africa and is bordered by the Mediterranean Sea. The population of Morocco is 33.8 million people, and its growth rate stands at 1.25 percent. The climate of Morocco is diverse due to its location and splits the country between two different climate zones. The north coastal region of Morocco has Mediterranean climate while the south of Morocco deals with Saharan climate. In the north, rainfall can be equivalent to about 2 meters while rainfall in the South can be below 25 millimeters (Sow et al, 2015). This difference in climate throughout the country means that the effects of climate change can have that much more of an impact. In comparison to Egypt, the amount of bare land throughout Morocco is considerably low while the amount of forest is greater. Also, the population density of Morocco is quite different as it is more spread out compared to Egypt. The population of Morocco is spread throughout the country as its sources of water come from the coast and precipitation. Figure 3.1 shows the North African region and the differences between the landscapes of Morocco and Egypt are quite noticeable. Compared to other North African countries, Morocco has far more fertile land than deserts or bare areas. Due to the availability of more fertile area throughout Morocco, the agricultural sector plays a significant role in the economy. Agriculture and industry are the two primary aspects of the economy and are concentrated throughout the coast. The dimensions of slow onset climate change that are currently present in Morocco and that will intensify over time are elevated temperatures, variability in rainfall, rises in sea levels,

Figure 3.1: Land use and population growth in North Africa



Source: Schilling et al., 2012

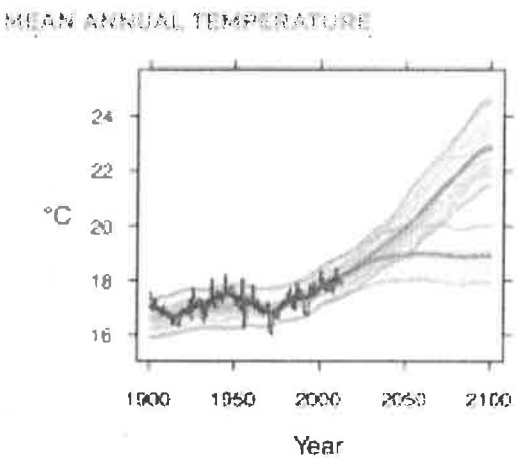
flooding, and droughts. While rainfall will decrease in the long term, the frequency and intensity of torrential rainfall will also increase in the future leading to more flooding. Flooding is a major issue due to the vulnerability of the Moroccan coast. As these dimensions of climate change take effect, water availability will decline leading to declines in agriculture. As productivity becomes an issue for farmers, water availability declines, and sudden onset disasters increase; the likelihood of migration becomes higher for families and individuals. Morocco is considered a transit country due to how close it is to Europe (Spain). Individuals will come to Morocco before they make their journey to Europe which makes migration an important social dynamic. This chapter will focus on the impact that climate change has on internal and international migration patterns throughout the country. The specific dimensions of climate change in Morocco will be analyzed along with its effect on the economy. Migration plays an important role in the socio-

economic landscape of Morocco, making it crucial to understand how climate change can shift migration trends.

4.1: Elevated Temperatures

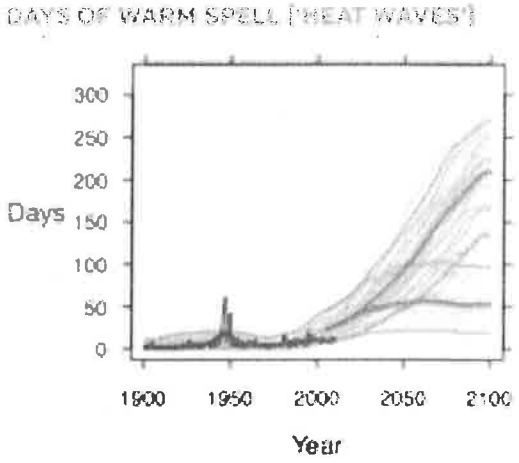
Elevated temperatures is a dimension of climate change that will affect the landscape of Morocco and the health of individuals. The mean annual temperature is projected to rise by 5.5 degrees Celsius on average from 1990 to 2100 (WHO, 2015). Graphs 3.1 and 3.2 show that there is indeed an upward trend regarding temperature. Graph 3.1 shows that the mean annual temperature will continue to rise to about 24 degrees Celsius by the end of the century under a high emissions scenario. However, under a low emissions scenario, the annual mean temperature can remain at or under 20 degrees Celsius. As the mean annual temperature increases, the duration of heat waves will also increase as seen in graph 3.2. By the end of the century under a high emissions scenario, heat waves can last up to 250 to 300 days. Under a low emissions scenario, heat waves could last up to 100 days by the end of the century. These graphs show that if adaptation to climate change does not occur within the century, elevated temperatures will

Graph 3.1: Mean Annual Temperature 1900-2100



Source: World Heath Organization (WHO), 2015

Graph 3.2: Days of Warm Spells 1900-2100



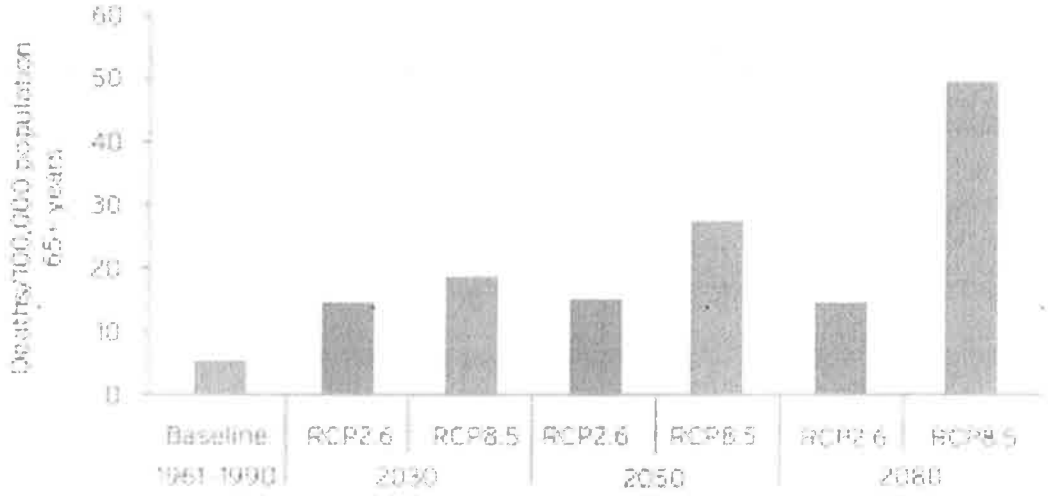
Source: World Heath Organization (WHO), 2015

become a norm throughout Morocco. This increase in the temperature has adverse impacts on different sectors of the economy. The agricultural sector will be impacted due to higher evaporation rates and increased water requirements for vegetation. At the same time, higher temperatures put some species of plants at risk of extinction. Moreover, higher temperatures will put stress on water availability. Elevated temperatures will increase evapotranspiration[7] throughout the region. As water evaporates at a faster rate than it is replaced by precipitation, water availability will continue to remain a major issue. The impact of climate change on the agricultural sector and water availability will be discussed in further detail later on in this chapter. One of the main issues that elevated temperatures present is the impact that it will have on the health of the population. Higher temperatures will affect children and the elderly the most and will raise the risk of contracting infectious diseases. Elevated temperatures will increase heat-related mortality throughout Morocco since children and the elderly are more likely to suffer from heat-related illnesses. Graph 3.3 projects the amount of deaths per 100,000 under high and low emission scenarios till 2080 for those over 65 years old. Elevated temperatures will raise the amount of elderly killed due to excessive heat. The WHO projects that under a high emissions scenario there will be 50 more deaths by 2080 compared to the baseline of 5 deaths between 1961 and 1990. On the other hand, if actions are taken to reduce emissions the number of elderly deaths due to heat-related illnesses could decrease to around 14 deaths. While the elderly are at risk of heat-related illnesses, so are children. Children who live in developed countries often have compromised immune systems due to poor sanitation, and lack of clean resources. Graph 3.4 shows the death of children under the age of 15 due to diarrheal disease in Morocco in 2030 and 2050. While the graph shows that the number of deaths due to diarrheal

[7] Evapotranspiration is the sum of evaporation and plant transpiration from the Earth's land and ocean surface to the atmosphere

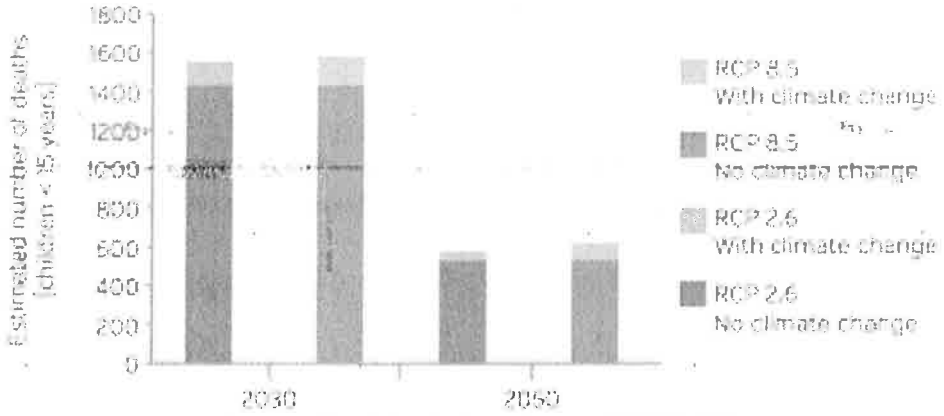
disease will decrease, the number of deaths attributable to climate change increases. In a high emission scenario, 10.5 percent of all 1600 diarrheal deaths in 2030 can be attributed to climate change. In comparison in 2050 under a high emissions scenario, approximately 14.7 percent of all deaths will be attributable to climate change (WHO, 2015). Higher temperatures will increase the risk of children contracting diseases, including diarrheal diseases. Furthermore, high temperatures will ultimately have negative impacts on the landscape and population of Morocco. As temperatures lead to unemployment, declined productivity, and increased health risks, more individuals will choose to leave the affected area of the country. As the quality of life for families declines, international and internal migration become the most appealing option to mitigate the effects of elevated temperatures.

Graph 3.3: Heat-Related Mortality in 2030, 2050, and 2080 Under High and Low emission Scenarios



Source: World Heath Organization (WHO), 2015

Graph 3.4: Diarrheal Death Projections in Children 15 and Younger Under High and Low Emission Scenarios 2030 and 2060



Source: World Heath Organization (WHO), 2015

4.2: Sea Level Rise

Sea level rise is one of the dimensions of climate change that will have devastating impacts on the Moroccan economy, and will likely lead to high levels of displacement. The coastal zone of Morocco is nearly 3500 kilometers long and is bordered by the Mediterranean Sea and the Atlantic Ocean. The coast of Morocco is a large driving force of the economy as more than 60 percent of the population live in coastal cities, and about 90 percent of all industry is located in these coastal cities (Snoussi et al, 2006). Sea level rise is one of the major threats that the country faces due to the concentration of the population and industry that reside on the coast. Morocco currently faces coastal erosion, pollution, and salinization each of which will be intensified by rises in sea level.

Sea level rise and inundation are two of the other dimensions of climate change that can have an impact on the Moroccan economy. Since so much of the population and economy reside on the coast, it is crucial to understand how sea level rise can lead to the displacement of individuals and economic decline. The IPCC expects sea-levels to rise by .1 meters by 2030, and .17 meters by 2050. This increase in sea level will increase the vulnerability of the Moroccan

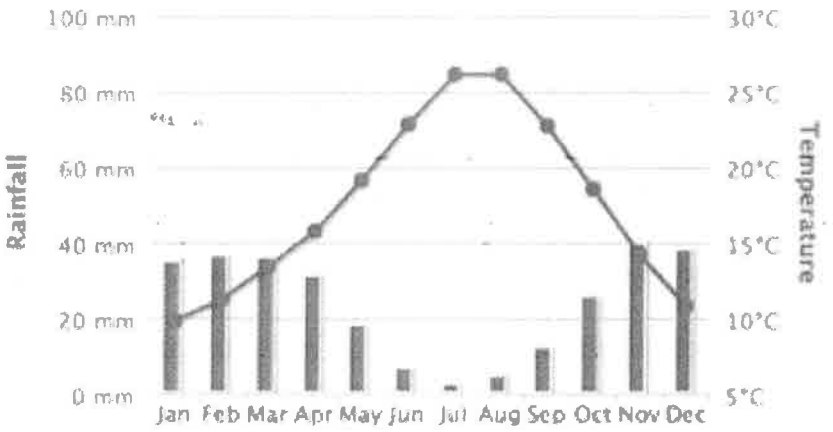
coastline due to intensified coastal erosion. The city of Casablanca serves as a prime example of how vulnerable some regions of Morocco are to sea level rise. The World Bank has identified Casablanca as one of three major MENA cities (the others being Alexandria and Tunis) that are at risk to lose over one billion dollars over the next two decades due to climate change. About 40 to 50 kilometers of the coast around the city is at high risk of coastal erosion and sea level rise (Tangermann et al, 2016). The city is home to over four million people, and its population is projected to grow by another one to two million in the next 15 years. One of the main reasons that Casablanca is so vulnerable to sea level rise is due to the infrastructure of the city. Infrastructure throughout the city is poorly constructed or old and in the wake of sudden onset disasters like flooding or storm surges, these structures are likely to fall and deteriorate. Also, a greater part of the city is built on the low-lying coast which sets up the city for intensified urban density. As urban density increases, the city and its population become more vulnerable to sea level rise and potential flooding due to inadequate drainage systems throughout the city. Sea level rise has also translated to coastal erosion which is currently impacting the coast of the city. Beaches have been steadily retreating along the ten kilometers stretching from the eastern end of Casablanca and the Mohammedia power station. By 2030 sand beaches are expected to retreat by 15 meters throughout the coast of Morocco (World Bank, 2011). While sea level rise is a primary driver of coastal erosion, it is also aggravated by sand mining that occurs all along the coast of the country. Mining that occurs on the coast is both legal and illegal making it difficult to measure the extent to which it is affecting the coast. The IOM has described the mining operations as the world's largest which is having severe implications on coastal development and resilience to climate change. As these mining operations continue on the coast, mitigating the effects of sea level rise will continue to become more difficult.

Rises in sea level can lead to higher salinization throughout out Morocco as well. As mentioned earlier in this paper, salinization creates issues for agricultural production. As sea levels rise the intrusion of seawater leads to salinization of groundwater and soil. Along with rises in sea levels, pumping of groundwater also intensifies the salinization process. As more groundwater is pumped, the likelihood of seawater intrusion increases putting certain reservoirs at risk. As salinization increases throughout Morocco, it will have a direct impact on agricultural production. In Morocco, it is estimated that 35 percent of irrigated agricultural areas are affected by salinization, and this number increases to 80 percent in the province of Ouarzazate (Schilling et al, 2012). Salinization will be intensified by sea level rise and in turn, will have an adverse effect on agricultural production. The effect of salinization, coastal erosion, and sea level rise on the agricultural sector, and its impact on migration will be analyzed in more depth later on in this chapter.

4.3: Levels of Rainfall, Flooding, and Droughts

Morocco's climate differs greatly from the northern region to the southern region. As mentioned before the country suffers from a cruel paradox in the form of advantageous precipitation patterns in the northern regions, but with very poor soil quality, and vice versa in the southern regions (Ouraich et al, 2014). Since this is the case, the effects of climate change will have different effects on each region. The north of the country will likely suffer from variable rainfall patterns while the southern region of Morocco will suffer from droughts. The rainy season in Morocco lasts from October to April, and it often leads to flooding. Graph 3.5 shows the average temperature and average rainfall from 1900 to 2012. It is apparent that the most rainfall occurs from October to April. These rainfall and temperature trends will likely change within the century as climate change takes its toll on the environment. Since 1970 mean

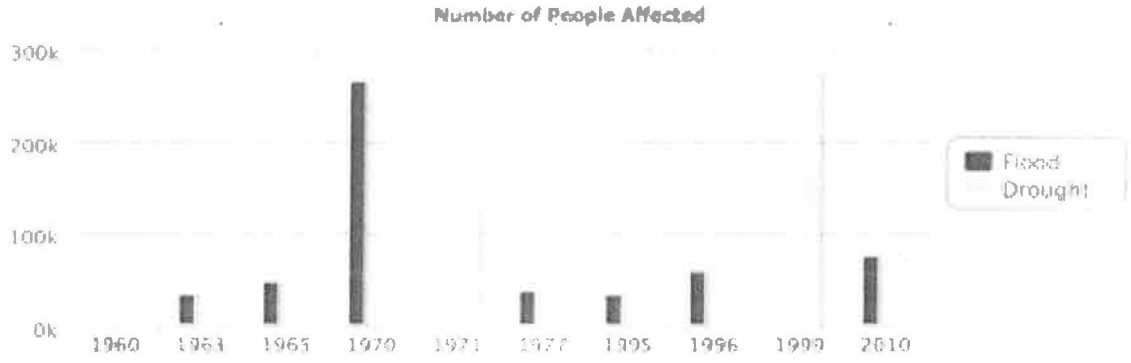
Graph 3.5: Average Monthly Rainfall and Temperature 1960-2012



Source: World Bank, Country Historical Climate - Morocco, 2017

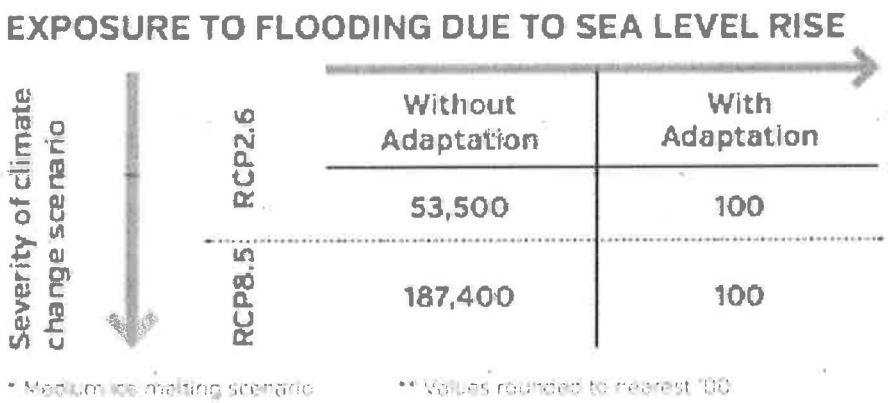
annual rainfall throughout Morocco has declined and will continue to decline. While overall levels of rainfall will decline the Northern region of Morocco, the area will be subject to increases in sudden onset disasters. The likelihood of torrential rainfall will increase, making Northern Morocco and its coast more vulnerable to flooding. At the same time, these decreases in levels of rainfall will

Graph 3.6: Number Of People Affected By Flood and Drought 1960-2010



Source: World Bank, 2017

Table 3.1: Exposure to Flooding Due to Sea Level Rise Under Low and High Emission Scenarios



EXPOSURE TO FLOODING DUE TO SEA LEVEL RISE

Severity of climate change scenario	Without Adaptation	With Adaptation
RCP2.6	53,500	100
RCP8.5	187,400	100

* Medium ice melting scenario ** Values rounded to nearest '00

Source: World Heath Organization (WHO), 2015

increase the frequency of droughts, and the length at which they last in the southern region of Morocco.

Flooding is one of the main sudden onset disasters that Morocco faces. From 2002 to 2011 nine of the ten top natural disasters were floods due to torrential rainfall in localized areas. Graph 3.6, shows that floods have had the most devastating impact on the population in terms of magnitude. Moreover, increases in the frequency of torrential rainfall along with sea level rise will leave more individuals and families vulnerable to flooding. Table 3.1 shows that many people that will become at risk of flooding due to sea level rise. With adaptation to sea level rise, the number of people that can be at risk to flooding can remain at 100 individuals under a low emissions scenario and a high emissions scenario. However, without adaptation under a high emissions scenario over 187,000 individuals will be at risk to flooding. As flooding becomes more frequent and increases in severity the likelihood of individuals that migrate will increase. As mentioned before the infrastructure throughout Morocco is poor due to the number of buildings and houses that are made with clay. The individuals that likely displaced at the highest

rate would be the poor. Most of the poor throughout Morocco live in clay houses which can be easily destroyed by flooding. Those individuals will likely migrate to another area in the country or internationally since moving outweighs the prospect of rebuilding in the same area.

While flooding is a possibility in the future for the northern region of Morocco, the southern region and other places will suffer from droughts. According to the World Bank, droughts are number one on the list of natural disasters that impact the most people, and have the most economic losses (Tangermann et al, 2016). One part of Morocco that is being affected by an increase in droughts is the Oum Er Rbia river basin.[8] The basin provides half of the countries water for irrigated agriculture but has been dealing with droughts over the years reducing water availability. In the past decade, rainfall has been significantly lower than average levels, that the irrigation water available was only half of the designed volume (Tangermann et al, 2016). To make up for this loss, water has to be pumped up from the ground. While the drying up of the basin is one example of how droughts are impacting Morocco, desertification is another result of lower precipitation rates and droughts. Oases throughout Morocco are home to about 1.8 million individuals, and they account for 15 percent of the total land area (Tangermann et al., 2014). Oases throughout Morocco are drying up, as over a dozen oases throughout the country have already seen a 40 percent decline in crop area. This is mainly due to droughts that are occurring more often and increased populations in these areas. Droughts are drying these areas up, and at the same time, an increased population leads to overuse of the area. As population and droughts continue to increase agricultural productivity will dramatically increase leading to increased internal migration to urban areas.

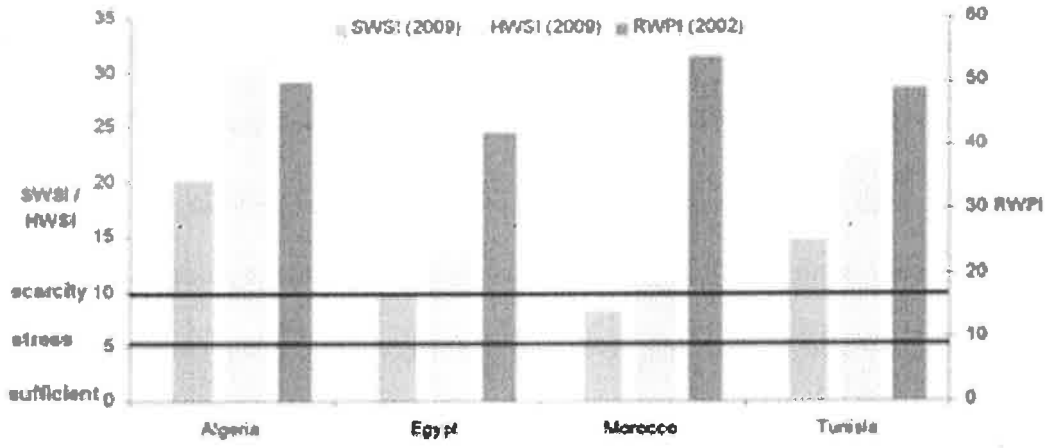
[8] The Oum Er Riba is the second largest river in Morocco and plays a major role in agriculture throughout Morocco

4.4:Water Resources and Availability

As climate change takes its toll on the Moroccan environment, there will be downward pressure on water resources throughout the country. Higher temperatures throughout the MENA region over the course of the next century will lead to declining water availability due to higher evaporation rates in reservoirs. Also, less rainfall will have downward pressure as well since Morocco is highly dependent on rainfall. Each of these dimensions of climate change will impact water resources throughout Morocco and in turn, will make the possibility of migrating more appealing for individuals and families.

While this is an issue throughout the MENA region, it is not considered to be a major problem in Morocco. Morocco is a country that relies on rainfall for most of its water since the Northern part of Morocco receives about 2 meters of rainfall. While this may be the case, in a study done by Schilling et al. (2012), Morocco was identified as the country with the highest

Graph 3.7: Comparison of Water Indices
for Four North African Countries



Source: Schilling et al., 2012

Reversed Water Poverty Index (RWPI)[9]. WPI measures the effect that water scarcity and water provisions have on human populations no a scale from 0 to 100. Graph 3.7 shows that this is the case as Moroccos RWPI stands at over 50, indicating that water scarcity and water provisions have the most effect on the Moroccan population in comparison to the other three countries. The other parts of the graph include a Hydrological Water Stress Index (HWSI) and the Social Water Scarcity Index (SWSI)[10]. These indexes reveal that Morocco is indeed facing water stress with respect to the SWSI, and is dealing with scarcity according to the HWSI. From this graph, it is apparent that while water availability is an issue of concern throughout Morocco, water stress is much higher in other North African countries.

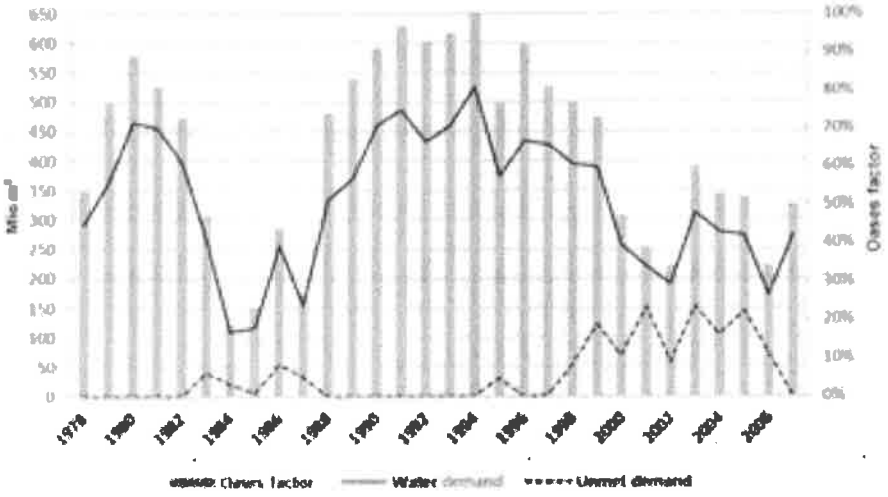
One of the reasons that water availability is considered a less than major issue throughout Morocco is due to certain adaptation strategies that are used and due to its diverse climate. Morocco is one of the countries in the world that is leading the charge against climate change and is taking considerable efforts to mitigate its effects. These adaptation strategies will be analyzed further in the final chapter of this paper. Also, since the climate of Morocco varies considerably the impression is given that water availability is not much of an issue. While this is the case for the Northern part of Morocco, the opposite is true for the Southern region which is more arid. In the study done by Johannsen et al. (2016), they can identify the Middle Dra Valley as an area of concern in the Southeastern region of Morocco. Johannsen et al. (2016) identify six oases aquifers that are fed by the Draa river and the effect that climate change has had on water

[9] Originally in this study a Water Poverty Index (WPI) was used, however for graphical representation the index was turned into a RWPI. WPI measures water provisions, and a high score indicates higher water provisions. RWPI was calculated by subtracting WPI from 100 in order for the index to be represented on the graph accurately. Therefore a higher RWPI indicate a lower water provision.

[10] HWSI measures the number of hundreds of people per one million meters cubed. SWSI on the other hand takes the HWSI and divides it by the human development index that is provided in the study by Schilling et al. (2012). That number is then corrected by a factor of 2.

availability and water demand throughout the valley. From their findings, they can see that availability has decreased which has consequently led to a decrease in demand. The El Mansour Eddahbi reservoir was built to manage water distribution to the six identified oases in the Middle Dra Valley. Since it was built, the reservoir capacity has decreased from its original capacity of 583 million meters cubed to 438 million meters cubed, and rainfall has only sufficiently filled this void in 13 years between 1972 and 2002 (Johannsen et al, 2016). Moreover, graph 3.8 shows the impact that climate change has had on the six oases from 1978 to 2007. Over the last decade, water demand has decreased, along with oases factor[11], while unmet water demands have increased. The oases factor over the years shows that farmers are decreasing the size of their

Graph 3.8: Mean Annual Water and Unmet Water Demand in the Six Oases 1978 to 2007



Source: Johannsen et al., 2016

fields due to lack of water and or fertile land that is available. The oases factor was high throughout the 90's due to consistent droughts that caused dramatic declines in agricultural production. In the 21st century, the oases factor stood around 50 percent while water demand

[11] Oases factor is the amount or percentage by which farmers reduce their field sizes. This is an adaptation method when reservoir fillings are low in the beginning of the growing season.

stood between 200 and 300 cubic meters. At the same time, unmet water demand remained close to 150 cubic meters. This indicates that water requirements are not being met in the region and these numbers could increase if climate change is dramatic as it is projected to be. These findings by Johannsen et al. (2016) show that while the Northern region may not be facing high levels of water stress; the southern region is highly vulnerable to water stress and water scarcity.

While water stress due to climate change will vary over the next couple of years throughout Morocco, increased population density throughout the country will also pose issues. Urbanization throughout Morocco is at a steady 50 percent, while the population is projected to grow by ten million people by 2050. As urbanization increases along with population, water availability will continue to decline as more individuals will need access to clean water. Furthermore, water availability and or water stress are issues that are a direct result of climate change and will have direct implications on migration trends. Water stress will negatively impact the agricultural sector of the economy making it harder to make a living for the majority of low-skilled workers throughout Morocco. The implications of climate change on agriculture will be analyzed in the next section since agriculture is a large part of the economy.

Table 3.2: Agriculture and Climate Change Impact in North Africa

Sectoral composition of GDP and labor force in North Africa

State	GDP (est. 2010)			Labor force (est.)		
	Agriculture percentage	Industry percentage	Services percentage	Agriculture percentage	Industry percentage	Services percentage
Algeria	8.3	61.5	30.2	14 (2003)	13.4	NA
Egypt	13.5	37.9	48.6	32 (2001)	17	51
Libya	2.6	63.8	33.6	17 (2004)	23	59
Morocco	17.1	31.8	51.4	44.6 (2006)	19.8	35.5
Tunisia	10.6	34.6	54.8	18.3 (2009)	31.9	49.8

Source: Schilling et al, 2012

4.5: Agricultural Production

Agriculture is and has been a large part of the economies of the countries in the MENA region. It is the sector that employs a significant proportion of the population due to higher levels of poverty that exist throughout the region. Table 3.2 can show the breakdown of the economies of the five main countries in the North African region. Of the five main countries in the North African region, Morocco's agricultural sector accounts for 17.1 percent of overall GDP. While Morocco's agricultural sector accounts for a significant portion of its GDP, its industrial sector accounts for only 31.6 percent of the economy (which is the lowest among the five countries). Regarding its labor force, Morocco has the highest percentage of its labor force employed in the agricultural sector at 44.6 percent. Another part of the economy that goes hand in hand with agriculture is fisheries. This is because fisheries represent 55% of agricultural food exports and employ about 400,000 jobs (Berkat et al, 2006). Morocco is a country that lives off the water, where fishing is a means of employment and a means of obtaining food. It goes hand in hand with agriculture and employs a significant number of the labor force. Fisheries are popular because almost 78 percent of the land (56,000,000 hectares) is in dry zones or desert zones while the rest of the area is in semi-arid zones or humid zones. Only about 12 percent (5,800,000 hectares) of land is considered arable which indicates that the land is cultivated or is covered by forest. A small percentage of total land throughout Morocco is used for agriculture which makes the impacts of climate change greater in these areas. The amount of land that is irrigated throughout Morocco is very little (almost 13 percent) since the country is very dependent rainfall. Declines in rainfall, elevated temperatures, and rises in sea level all have the ability to lower agricultural production over the years.

In Morocco, the shape of the agricultural sector is an indication of how the general economy is doing. When the agricultural sector is doing well, the economy does well and vice versa. Throughout the country, four cereal crops (wheat, durum wheat, barley, and maize) dominate the agricultural sector. These crops on aggregate account for 55 per cent of total value-added of crop production and occupy 65 percent of the agricultural area (Ouraich et al, 2014). These crops are driven by precipitation since most of the cultivated area is located in non-irrigated areas. Conversely, crops that are irrigated are export crops such as citrus and vegetables represent 15 per cent of value-added crop production and respectively occupy 0.85 and 3 percent of the total agricultural area (Ouraich et al, 2014). This distinction of crops that are driven by rain and or irrigation is crucial to understanding how climate change will impact agricultural productivity and future yields. From 1990 to 1991 precipitation increased by about 128 percent during critical rainfall periods from January to March[12]. This increased rainfall during this period led to the yield of the four major cereal crops to increase by 41 percent. On the contrary, a decrease in rainfall by 78 percent from 1999 to 2000 led to a yield decrease of these crops by 51 percent (Ouraich et al, 2014). These past changes in yields due to rainfall show how significant rainfall is to agriculture and the whole economy in Morocco. It should be noted that rainfall throughout Morocco will likely have the largest impact on agricultural production. This is because rainfall can influence both sudden onset disasters and slow-onset disasters as well. Rainfall variability can influence floods and droughts which are the two disasters that have the most impact on Morocco. While sea level rise is important to the climate change migration nexus, its impact on agriculture is relatively minuscule compared to rainfall variability. Sea level

[12] January through March represent the growing season throughout Morocco. Increased rainfall during these months can lead to high levels of agricultural productivity.

rise will likely have a larger influence on migration patterns, and for that reason, sea level rise will be discussed further in the section dealing with migration.

In the study done by Gommes et al. (2007) the impacts of climate change on the agricultural sector of the economy are assessed along with projections for specific crops. This study uses a Crop Specific Soil Water Balance (CSSWB)[13] model to see how yields of certain crops fair under certain circumstances of climate change. Along with this Gommes et al (2007) assess yield changes based on two separate scenarios, A1 and B2[14]. Along with this, the crops are broken up into six different classes. Classes A and B are crops that are irrigated and are grown using more industrial methods. Classes C through F are rain-fed crops that include the four major cereal crops that were mentioned earlier. Gommes et al. (2007) found that the classes of crops from C to F were the ones that will be impacted most by climate change. Table 3.3[15] shows the impact that each scenario will have on certain classes of crops. Also, graphs 3.8 and 3.9 are used to give a visual understanding of the effect of climate change on agricultural production. From these visuals, it is apparent that the irrigated crops are the ones that will not be impacted as drastically or at all by climate change. Class A and B crops all see an increase in productivity from 2030 to 2080. On the other hand, crops in classes C through F all see a decrease in yields from 2030 to 2080 in both optimistic and pessimistic scenarios. This is attributed to the decline

[13] The CSSWB model describes the water relations of a soilplant-atmosphere system and puts out the variables (indicators, predictors) that will be used to estimate yields. This model provides value-added variables that are related with crop yields which derive from the direct link between the water balance and the energy balance of crops.

[14] Scenario A1 is a pessimistic scenario where carbon emissions continue to increase, and economic growth is attributed to polluting technologies. Scenario B2 is an optimistic scenario where the focus of development is concentrated in local solutions and technological development is cleaner yet slower.

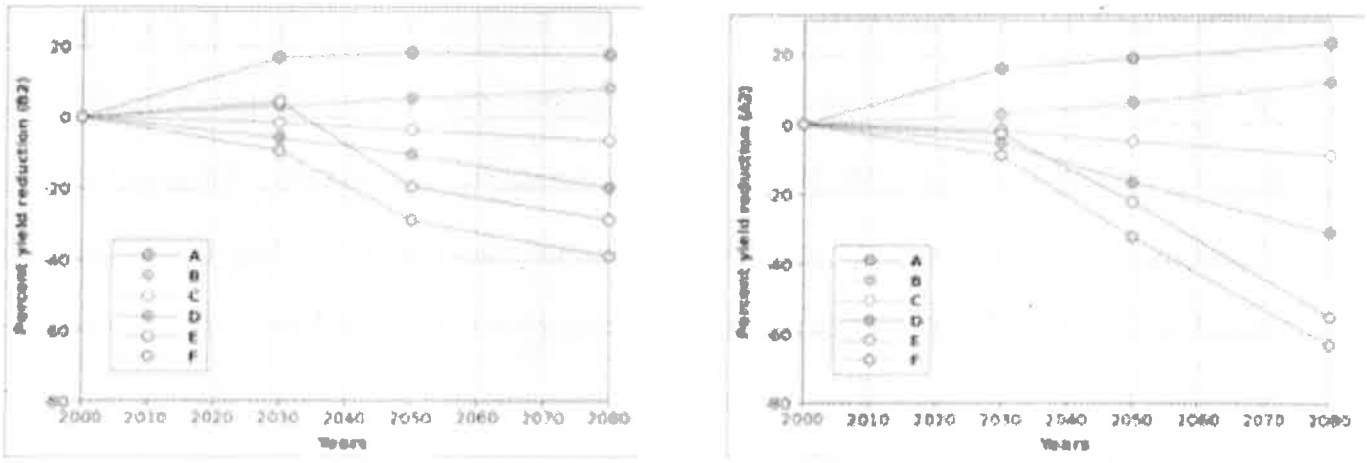
[15] Class A and B (Irrigated): Heterogeneous group of irrigated crops (A), fruits and vegetables (B)
Class C to F (Rain-fed): Fodder crops and vegetables (C), cereals and legumes (D), wheat and barley (E), and winter crops such as cereal crops, legumes, and oil crops (F)

Table 3.3: Percent Yield Change for 6 Impacts Classes Under Scenarios A1 and B2 in 2030, 2050, and 2080

	Scenario A2			Scenario B2		
Class	2030	2050	2080	2030	2050	2080
A	16	19	23.33	16.67	18	17.67
B	2.8	6.27	12.26	3.07	5.25	8.25
C	-1.67	-5.03	-8.72	-1.59	-3.64	-6.56
D	-5.49	-16.77	-31.11	-5.81	-10.6	-19.81
E	-2.71	-22.36	-55.14	4.29	-19.64	-28.93
F	-9.12	-32.41	-83.24	-9.47	-29.12	-39.24

Source: Gommes et al., 2007

Graph 3.9a and 3.9b: Percent Yield Change for 6 Impacts Classes Under Scenarios A1 and B2 in 2030, 2050, and 2080



Source: Gommes et al, 2007

in rainfall that will be felt over the course of the century. As temperatures increase throughout Morocco, the amount of water needed for successful crop growth will increase as well. The four major crops which include wheat, barley, durum wheat, and maize are separated into crop classes E and F. These classes are facing yield declines up to 30 percent by 2050, and by at least 40

percent by 2080. These projections indicate that the economy of Morocco will be under duress if these crops are unable to match expected production. As mentioned before, if the agricultural sector is unable to be the productive part of the sector it is the whole economy is likely to stagnate. These figures and numbers give a good indication of the effect that climate change can have on developing countries such as Morocco.

The potential impact of climate change on the Moroccan economy will prove to be devastating if adaptations methods are not taken in the future. Agriculture employs almost half of the labor force and if production declines, unemployment will likely increase. Higher unemployment rates and reductions in food availability will be some of the implications of a stagnating agricultural sector. Along with increased water stress, families will find it more difficult to sustain a quality of life that is satisfying. The impacts of climate change on these economic demographics will increase the appeal for individuals and families to migrate internally and internationally. Migration in Morocco is an important social demographic that needs to be analyzed in detail because it is a transit country. The next section will focus on migration trends throughout Morocco, and how climate change will change them and even increase internal and international migration.

Migration

Migration in Morocco is one of the most important social demographics within the country due to the propensity at which individuals and families choose to migrate. Between Egypt, Morocco, and Tunisia about 7 million individuals were living abroad, of which 3.1 million were Moroccan (Schramm, 2006). The transformation of Morocco as a migration powerhouse stems from the conquest of the French in Algeria in 1830. As the French took

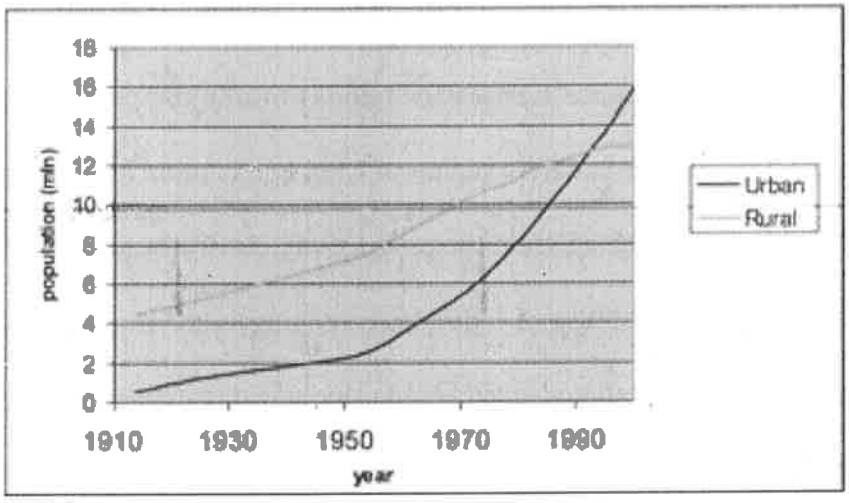
control of the Algerian coast, the demand for farmers and workers on the coast increased dramatically. These opportunities inspired circular or temporary migration from Morocco, changing and impacting migration patterns drastically. It was then in 1912 that the Franco-Spanish Protectorate[16] was established. France controlled the heartland of Morocco while the Spanish were limited to territory in the South. This allowed for new infrastructure to be built leading to the expansion of coastal cities. In turn, new markets emerged for rural to urban internal migration. At the same time, the two World Wars influenced increased migration into Europe, specifically France. These events each influenced higher rates of both internal and international migration throughout Morocco making it one of the highest emigration countries in the world. Since this is the case, it is crucial to identify certain migration trends throughout the country so that the effects of climate change can be assessed.

4.6: Internal Migration

Internal migration throughout Morocco has been influenced due to the rise of urbanization. As cities continue to develop and prosper, the number of individuals from rural areas to urban areas increased significantly. This is one of the major dimensions of internal migration as people from rural areas dominated by agriculture move to areas that are urban and are thriving off industry. While rural to urban migration is a popular trend, rural areas are becoming more popular destinations for migrants as well. This is due to increased development of rural areas and small and medium-sized towns throughout Morocco. These developments are attributed to remittances from individuals residing in other countries. These two trends of internal migration (rural to urban, and rural to rural) will be analyzed in the next section to

[16] A protectorate is when a dependent territory is protected and partially controlled by other stronger sovereign state. In exchange a protectorate is usually subject to certain obligations.

Graph 3.10: Urban and Rural Population Grown 1910 to 1995



Source: De Haas, 2005

understand how changes in rainfall and sudden onset disasters can impact migration.

Internal migration is often overlooked due to the propensity in which individuals from Morocco emigrate to other countries. Internal migration for individuals is one of many coping mechanisms that are used to counteract the impacts of climate change. One of the main migration trends that are seen throughout Morocco is from rural areas to urban areas. As mentioned before, an overwhelming amount of the population resides on the Moroccan coastline where the majority of the industrial sector is located. Most urban centers and cities in Morocco are located along the coast where the population is steadily increasing. Graph 3.10 shows that the urban and rural population were both growing steadily over the course of the 20th century. However, by 1990 the urban population overtook the rural population as the rural population started to decline. These figures are intriguing because while the urban population grew, birth rates were higher in rural regions. In the 21st century, the population in urban cities increased at more than four times the rate as rural areas from 2000 to 2010 (Wodon et al, 2014). This goes to show that urban to rural migration is the primary internal migration trend throughout Morocco. Some of the push factors

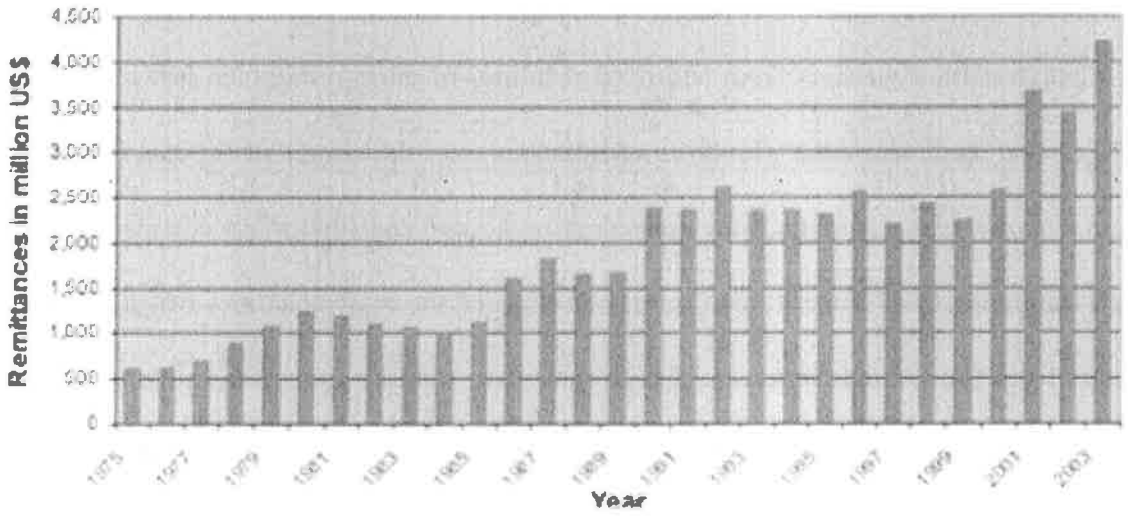
that that influence movement towards the coast towards urban cities include scarce resources, declined agricultural production, and poor standards of living. These factors are all intensified by climate change and in turn can increase migration trends towards coastal areas.

As mentioned before the Southern region of Morocco is more arid and often suffers from more droughts which can lower agricultural productivity. In the study done by Woden et al. (2014), they analyzed the probability of individuals moving based on certain demographics. In the study, they were able to find that weather shocks do indeed instigate migration out of affected areas throughout Morocco. Those who live in rural areas and are impacted climate change were more likely to move to the city of Casablanca. Casablanca is a popular destination for internal migrants due to the networks that are available. Historically, the number of internal migrants are often predominantly men due to the lack of networks that are available for women. Women who chose to migrate, often do not have access to networks in destination areas making them more vulnerable to human trafficking, or slave labor. For this reason, Casablanca is the city that can provide networks for both men and women who chose to migrate. The Greater Casablanca area alone still attracts 15 percent of all internal migrants throughout Morocco (Wodon et al, 2014). Networks are considered a pull factor since they can provide support for migrating families and aid the families in finding the appropriate destination to move to. Moreover, increases in the frequency of droughts have also created shanty towns in Southern parts of Morocco. Two examples include Tafilalt and the Draa region. In Tafilalt, almost a fourth of the population has migrated to urban centers due to climatic hazards and declines in agricultural production. Severe droughts and or flooding have made it near impossible to efficiently farm in this area. In the Draa region, out-migration has increased due to increases in the frequency and longevity of droughts. In a survey done by Woden et al. (2014) individuals within the regions stated that droughts that

usually come every three to four years are coming every two years. Due to this individuals (specifically women) must travel longer distances to retrieve water. Also, internal migration to urban centers has already started to create other issues. Migration to Casablanca has created more shanty towns throughout the city making it more susceptible to sea level rise. Also, increased population density increases the likelihood of social stress such as racism as tensions between certain groups rise. Competition for survival within urban centers sets up social and economic tensions that are likely to lead to conflict. The increased movement to urban areas also opens doors to more illegal activities which include black markets, and more informal economic activities. Furthermore, the impact of climate change on internal migration is present and will continue to get worse. As more individuals migrate to urban centers, the likelihood of tensions and vulnerability to other natural disasters increases. While this is an issue, rural to rural migration has been becoming a more popular trend.

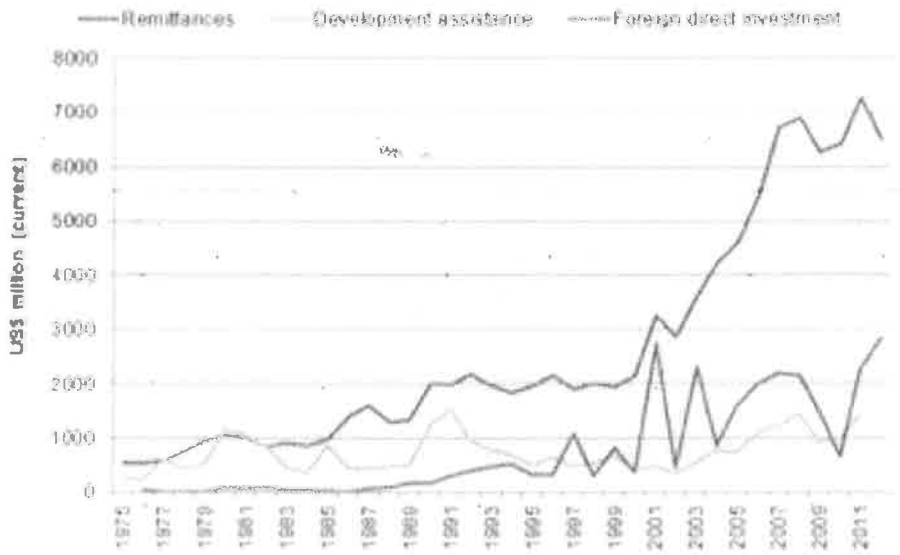
Rural to

Graph 3.11: Remittances to Morocco 1975 to 2003



Source: Schramm, 2006

Graph 3.12: Official Money Transfers to Morocco 1975 to 2011



Source: De Haas, 2014

urban migration is a popular option for individuals due to the economic opportunities and recent increase in urbanization of the Moroccan coast; however rural areas are also seeing increased development as well. One of the largest reasons for rural development is due to remittances throughout Morocco. Remittances play an import part of GDP and overall development of the country. The number of individuals who live abroad is continuously increasing including the number of high-skilled workers from Morocco resulting in more remittance flows to Morocco. Graphs 3.11 and 3.12 show the growth in remittances over the course of the last four decades. Graph 3.11 shows that remittances are indeed growing and that there is a correlation between increased remittances and international migration. One of the major changes was the number of individuals from the United States and Spain that were sending money. Remittances from the United States multiplied by a factor of 15 between 1997 and 2004, while those from Spain have jumped sevenfold (Schramm, 2006). The other graph shows that remittances have been substantially higher, and less volatile source of foreign exchange than official development

assistance (ODI) and foreign direct investment (FDI) (De Hass, 2005). This is significant because remittances have sustained Morocco's balance of payments, have alleviated poverty and contributed to income growth. Without remittances, almost 1.2 million Moroccan would fall back to absolute poverty (De Haas 2005). Remittances account for almost seven percent of GDP and is a stabilizing factor in the economy. Remittances are one of the reasons that individuals can remain in rural areas in time of economic hardship. Also, remittances are influencing rural development increasing the appeal of staying in rural areas or moving to other rural areas that are subject to more urbanization. Remittances lower the rate at which migrants move to urban areas and relieve pressure off urban areas that are already facing increased population densities. While rural to rural migration is becoming a more viable option, urban to rural migration will remain the more popular migration trend. Internal migration is one of the first options for individuals who are faced with immediate climate stress due to flooding or droughts or are affected by the long-term implications of climate change. As mention earlier international migration continues to increase and will continue to grow as internal migration to urban areas intensifies.

4.7: International Migration

Morocco is a country that is known for its high rates of international migration to European countries. As mentioned earlier, the French colonization of Algeria was one of the driving forces international migration in Morocco. As urbanization increased throughout Algeria, the need for workers increased. As urbanization continued to increase, it was post-war economic growth that spurred a migration boom at the start of 1960. As economies recovered from the effects of the second world war, there was an increase in the demand for unskilled labor. This inspired the emergence of "guest workers" from Mediterranean countries as European labor was

limited. Morocco had signed "guest worker" agreements with Germany, France, Belgium, and the Netherlands throughout the 1960's. These agreements initiated a volatile movement of migrants from Morocco to Europe in search of employment opportunities. Then the 1973 Oil Crisis shifted migration patterns even further as the demand for labor decreased, and European countries closed their frontiers to labor migrants (De Hass, 2005). This increased the number of permanent migrants throughout Europe and had decreased return migration due to political and economic tensions. It was after this oil crisis that family reunification became one of the larger driving factors for migration. Individuals would marry in Europe during their tenure as a labor migrant to legally return to the country. This method increased migration from Morocco to Europe as almost 400,000 Moroccans were granted the nationality of an EU member state from 1991 to 2000, which was more than any other immigrant group (De Hass, 2005). Moreover, labor migration along with family reunification are two of the main reasons that Morocco saw such great increases in emigration throughout the mid-1900's and is now one of the emigration countries in the world. Currently one of the larger issues that Morocco deals with is the emergence of illegal migration to Europe due to increases in irregular migration[17]. Morocco has developed into a transit country where individuals stop in Morocco before making their trip to Europe. While individuals from other countries are coming to Morocco to migrate elsewhere, irregular migration is attributed to climate change influencing the economic landscape of the country. As areas become more dangerous and living situations become unsuitable, the likelihood of migration elsewhere becomes more prominent. These next sections will serve to identify certain dimensions of international migration such as temporary and permanent migration, the

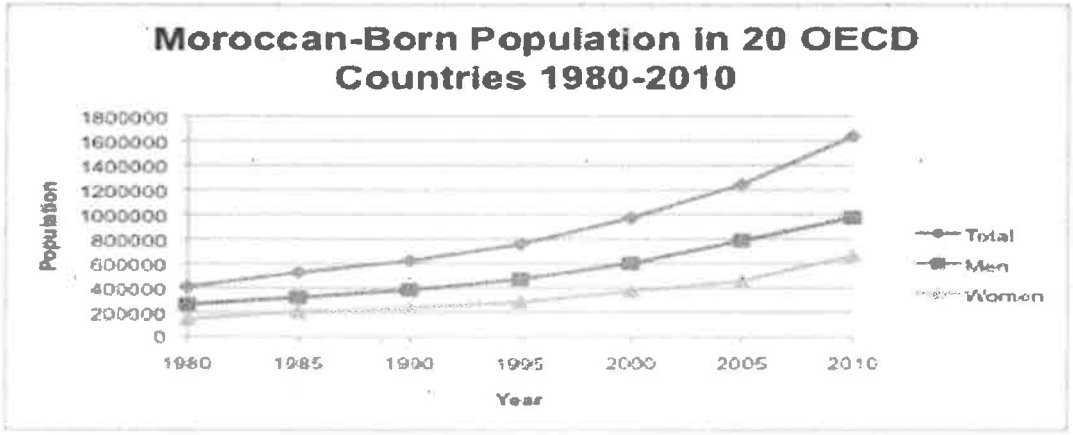
[17] Irregular migration can be defined as the influx of individuals from surrounding or bordering countries due to environmental change, conflict, or resource depletion. In the case of Morocco, irregular migrants come from other Sub-Saharan countries.

effects of brain drain, and irregular migration. By understanding these dimensions of international migration, the impacts of climate change are more understandable.

Temporary and permanent migration are two separate ways in which individuals can cope with or mitigate certain problems that they are faced with. Temporary migration due to labor opportunities was a popular form of migration throughout the 20th century. Due to the increased demand of labor individuals were able to work in Europe and return to Morocco after an extended period. Around the mid to late 1900's the length of those who temporarily migrated stood at a duration between seven to ten years (Hamdouch and Wahba, 2012). As time progressed, temporary migration turned to permanent migration. Currently, the number of individuals who migrate permanently is significantly higher than those who migrate temporarily. Some of the push factors that influence migration in Morocco can be attributed to underdevelopment in some areas of Morocco where infrastructure is poor and overall quality of life are low. Economic instability throughout the country is one of the main reasons for underdevelopment and continues to be a main driver of migration. Economic instability leads to higher unemployment rates throughout the country (especially for younger individuals) which push individuals to western European countries. Conversely, some of the pull factors that make migrating more desirable are higher wages and job availability. Job opportunities throughout Europe are vast for unskilled workers due to the labor needs of those countries. Low skilled workers fill the employment void that is present in these countries due to jobs that are unappealing to residents of that country. The wage differential for unskilled workers between European countries and Morocco is substantial increasing the appeal of migration. While these push and pull factors influence migration, migration has also become a "norm" or a part of Moroccan culture. Migration to European countries (specifically western European countries) is

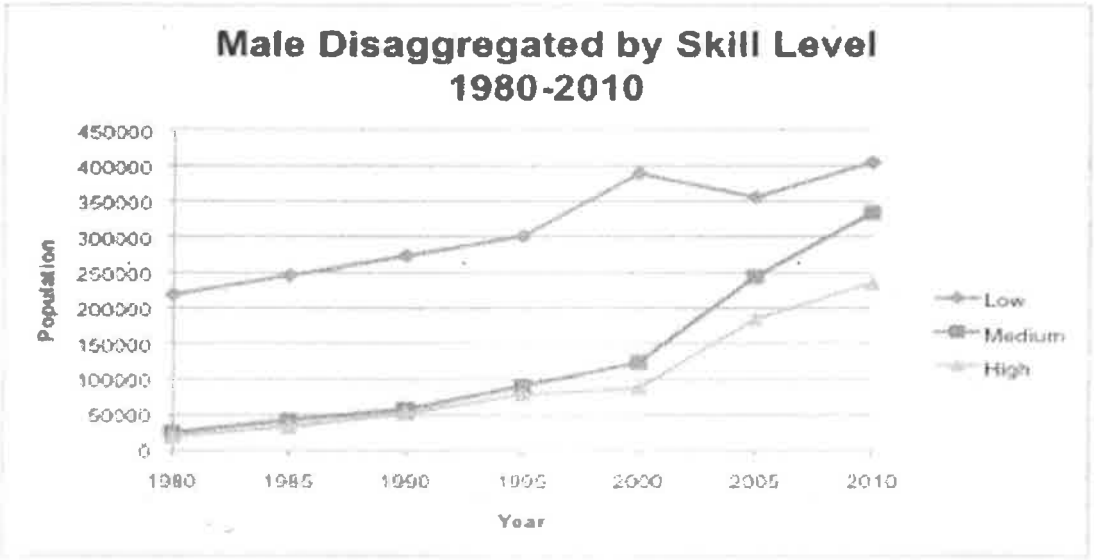
one of the most popular areas that Moroccans migrate to. As individuals grow up, the appeal of moving to Europe outweighs the appeal of staying in Morocco. These factors are some of the reasons that international migration has been increasing at an astounding rate. Graph 3.13, shows

Graph 3.13: Moroccan-Born Population in 20 OECD Countries 1980-2010



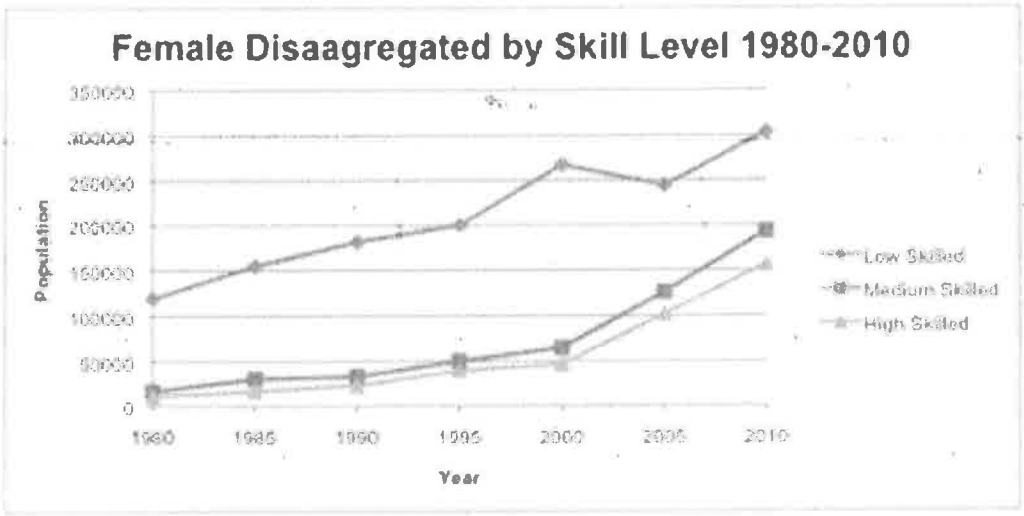
Source: Own Calculation based on IAB Brain Drain Data 2013

Graph 3.14: Male Population in 20 OECD Countries Disaggregated by Skill Level 1980-2010



Source: Own Calculation based on IAB Brain Drain Data 2013

Graph 3.15: Female Population in 20 OECD Countries Disaggregated by Skill Level 1980-2010



Source: Own Calculation based on IAB Brain Drain Data 2013

that from 1980 to 2010 the number of both men and women that migrate has been increasing rapidly. By the end of 2010, the number of Moroccans living abroad in OECD countries stood at over 1.6 million. The graph shows that this number will continue to increase dramatically over the next couple decades. Another reason that migration rates are increasing is due to an increase in brain drain. Overall individuals who are highly educated are leaving the country at an increased rate as well. Graphs 3.14 and 3.15, show that the number of highly skilled males and females that are migrating is increasing as well. Graph 3.15 shows that in 2010 the number of high-skilled females that migrated from Morocco stood at about 150,000. Graph 3.14 shows that in 2010 about 250,000 high skilled men migrated from Morocco. The main reason for this is due to better opportunities in other countries. Individuals who are highly educated will seek jobs in other countries that have higher wages and are safer to live in. From these graphs, it is apparent that international migration rates will continue to increase over the next couple of decades.

Something that should be noted is that as international migration increases, so will irregular migration.

Irregular or illegal migration is one of the largest issues that Morocco faces as it continues to increase annually. As mentioned before Morocco is considered a transit country since individuals come to Morocco before they migrate to Europe. While millions of Moroccans live in other European countries, there are an estimated 20,000 individuals of other nationalities entering Europe through Morocco annually (Lahlou, 2015). These individuals include those who

Table 3.4: Evolution of Irregular Migration From

Years	Canary Islands	Balearic Islands	Ceuta & Melilla	Total
2001	4,105	14,412	4,969	23,486
2002	9,875	6,795	Nd	16,670
2003	9,388	9,788	Nd	19,176
2004	8,426	7,249	Nd	15,675
2005	4,715	7,066	5,566	17,347
2006	**31,678**	**7,502**	**2,000**	**41,180**
2007	12,478	5,578	1,553	19,609
2008	9,181	4,243	1,210	14,634
2009	2,246	5,039	1,108	8,393
2010	196	3,436	1,567	5,199
2011	340	5,101	3,343	8,784
2012	173	3,631	2,841	6,645
2013	196	3,041	4,235*	7,472
2014	296	4,256	7,485*	12,037

Source: Spanish Ministry of the Interiors
Note: *From Syria: 2013 = 273, 2014 = 3,309.

Source: Lahlou, 2015

are looking for job opportunities in Morocco due to poor economic elsewhere, and also include those who are fleeing their home countries due to violent conflict and political instability. Most of these individuals who migrate illegally to Europe come from other sub-Saharan countries with the intentions of moving north. Almost three-fourths of illegal migrants enter near the city of Oujda which serves as the major entry point. Once these individuals can get into Morocco, their

next destinations are likely Spanish enclaves such as Ceuta and Melilla. People often take numerous risks to get around security and into these Spanish enclaves. Numerous deaths occur due to those who are killed while traveling by sea, to those killed by bandits or smugglers. Spain and Morocco have worked together to limit illegal migration into Spain by increasing security, building fences, and enhancing surveillance technology. Table 3.4, shows the number of individuals who have been arrested on arrival in Spain. After 2006, migration policies were tightened to reduce the number of migrants that were illegally migrating from the Canary Islands. While this was the case, these migrants were able to turn to other locations that were safer, and more accessible than the Canary Islands. While Morocco and Spain have come together to regulate the movement of these irregular migrants, illegal migration will continue to increase. The reason for this is due to increase environmental degradation and increased political tensions in other countries. While migration from Morocco will increase these numbers, climate change can also increase the number of individuals in other countries who seek refuge in Morocco or Europe. Climate change is also having similar effects on neighboring countries such as Algeria, Tunisia, and Libya. In addition to climate change, these countries are also faced with higher levels of violent conflict meaning that there will also be refugees fleeing due to war and unsafe living conditions. Climate change in Morocco will force individuals with little resources to explore illegal migration as a viable option and will intensify the number of individuals from other countries who use Morocco as a transit to Europe.

Of all the dimensions of climate change, one of the largest reasons for increased international migration (both legal and illegal) is due to the impact of sudden onset climate disasters such as droughts and floods. Rainfall variability by elevated temperatures will influence these sudden onset disasters as well as influence agricultural production and water availability.

Flooding and droughts are the ones that have the most impact on the Moroccan environment and are likely to force individuals to move out the country. Consistent flooding events sweep vulnerable areas of Morocco destroying infrastructure and forcing individuals to new areas. On the other hand, droughts and desertification are and will continue to decrease agricultural productivity. This will influence higher unemployment rates due to the inability of individuals to produce sufficient income, and food. While these climactic events are taking place (and will likely increase in frequency), the effects are more apt to be seen over the long term. In the short term, climate change is more likely to intensify already existing political and economic problems throughout Morocco. Due to higher security measures and increased resources needed to migrate internationally, individuals are likely to migrate internally first. Since urban centers are rapidly developing, individuals will contribute to increased vulnerability in these areas, making it harder to mitigate the effects that climate change may have on agricultural production or water availability. Here lies the issue. As more internal migrants come to more urban areas the vulnerability of urban areas increases, and these individuals are likely more vulnerable to other dimensions of climate change. As the population density increases in urban areas, political tensions will increase, and these individuals are more susceptible to sudden onset climatic events such as flooding. This will lead to more international migration and more illegal migration. Regarding brain drain, as climate conditions continue to affect large portion of the population, more highly skilled individuals will leave the affected areas permanently. As mentioned in the chapter on Egypt, these individuals are the ones that are needed to sustain economic and political stability. Although certain political and economic demographics will be intensified by environmental degradation, Morocco is a country who is currently leading the charge against climate change. The country has set in place policies and goals that will reduce vulnerability to

climate change, and influence economic development. These policies and adaptations methods that are used by Morocco, along with Egypt will be reviewed in the upcoming chapter to understand how these two countries aim to mitigate the effects of climate change on their respective economies.

Chapter 5: Egypt and Morocco Comparison

5.1: Difference and Similarities

Now that the dimensions of migration and climate change have been analyzed for both respective countries, it is crucial to point out the major similarities and differences between the two. Regarding climate change, both countries will suffer from similar rises in temperatures. In the study by the World Bank (2014), temperature rise in the Middle East and North Africa is projected to increase equally throughout the region. While temperature rise may be equivalent in both countries, the implications of elevated temperatures in both regions are different. One of the major differences between the two is the impact of changes on rainfall. Both areas are faced with reductions in rainfall; however, it is Morocco that becomes more vulnerable due to these changes. Egypt already receives minimal rainfall, and so changes in rainfall patterns are less dramatic. In the case of Morocco, changes in rainfall play a large role since rainfall dictates agricultural production and is a large source of water for the country. This reduction of rainfall that will occur will also lead to more desertification and increased instances of droughts. Egypt is an arid country that does not receive much rainfall and has been facing longer droughts. The region is comprised of lots of deserts, while the only fertile land is around the Nile, and off the coast. Morocco, on the other hand, has more fertile land and is facing droughts due to drying of oases. Reduction in rainfall is attributing to oases and reservoirs drying up or holding lower

levels of water. Water in these reservoirs and oases are replenished with rainfall; however, reductions in overall levels of rainfall are not replacing the lost water. Moreover, sea level rise, flooding, and salinization are dimensions of climate change that will have negative impacts on both countries as well. Both countries have large parts of their economies based in coastal cities (Morocco especially), and or near large areas of water (Egypt and the Nile). Sea level rise will cause parts of these coastal cities and or regions to be submerged and will make them more vulnerable to flooding. In the case of Morocco, flooding is one of the most reoccurring disasters which also displaces the most people specifically in Casablanca. Rainfall variability and rises in sea level will increases the frequency of flash floods and storm surges all across the coast. Egypt, on the other hand, is vulnerable to flooding all along the Nile river due to increased levels of cultivation, and the creation of the Aswan dam. These factors are causing land around the Nile to sink below sea level, leaving millions vulnerable to flooding. The population of Egypt relies on the Nile to maintain a stable way of life, while Morocco's economy is based off the coastal waters of the Mediterranean. While their sources of water differ, both countries are at risk to face increased instances of sudden onset disasters. These similarities and differences in the dimensions of climate change expose each respective countries population to increased vulnerability, therefore increasing the likelihood of displacement and migration as well.

Climate change within both countries can be differentiated as can the migration patterns. Internal migration patterns resembled each other between Morocco and Egypt. Urban to rural migration is popular due to increased urbanization throughout both countries. Cities are continuously developing making it a more attractive option for individuals who are seeking better opportunities. Also, those individuals who are affected by climate change are more likely to migrate internally before making the decision to migrate internationally. This refers to the

immobility paradox mentioned in chapter two. Some individuals impacted by extraneous factors such as climate change often do not have the resources to migrate, whether it is internally or internationally. For those who do have sufficient resources, internal migration is often the most feasible option. Internal migration is more likely since there are fewer restrictions and regulations to movement. Also, there are more resources available to migrants who migrate internally to urban centers than internationally to other countries. Before moving on, it should be noted that in both countries as individuals migrate to cities, the vulnerability of these urban areas increases. Also, individuals who migrate from rural to urban areas shift their vulnerability and do not necessarily erase it. For example, individuals who migrate due to poor agricultural production in Morocco due to climate change may move to a coastal city to seek other employment that is not reliant on the environment. While these individuals are no longer vulnerable to agricultural shocks, they are now vulnerable to sudden onset disasters (such as floods) that strike Moroccan cities. This shows that while migrating internally is a coping method in these developing countries (Morocco and Egypt), vulnerability to climate change cannot be entirely erased. Overall, the internal migration patterns between Egypt and Morocco are similar due to the similar circumstances that both populations face. On the other hand, international migration patterns differ quite a bit with the exception of high-skilled individuals who migrated out of both countries. In both countries, brain drain occurred as more high-skilled individuals continued to migrate out of the country over the past three decades. This is mainly due to lower economic and social conditions. As previously mentioned, individuals who have the resources are more likely to migrate out of dangerous situations. High skilled individuals have higher incomes and will choose to move out the country if living in the country of origin has become unsafe, or unstable. As urban population density continues to increase without proper

development, the appeal of living in these cities also decreases. Brian drain is similar in both countries, and it is a phenomenon that occurs in all developing countries. The main difference between the Morocco and Egypt are migration flows. International migration in Egypt flows more to Arab countries due to the option of temporary migration. Individuals travel to these Arab countries to work for extended periods of time and then return to Egypt. Temporary migration is a more attractive option than permanent migration since individuals can come back to their families. The remainder of individuals (mostly permanent migrants) that migrate internationally migrate mostly to Canada, Greece and the United States. These three countries were the most popular destinations for individuals from Egypt from 1980 to 2010 according to the IAB brain drain data. In contrast, international migration is more permanent that temporary in Morocco. The majority of international migrants travel to European countries due to the proximity of Morocco to Spain. The main destinations for these migrants are Spain, France, and the Netherlands. These were the most popular countries for Moroccan migrants from 1980 to 2010 and continue to be popular. Apart from migration flows, the other difference that can be made about international migration is that Morocco has become a transit country. Morocco now is considered a "hub" for refugees that are fleeing other countries dealing with violent conflict. The rate of individuals that come to Morocco to make the trip to Europe has been increasing over the past decade. Egypt faces illegal migration as well; however, it is not a destination for those individuals who are seeking to make the trip to Europe. Overall, these similarities and differences recognize the situations of vulnerability that exist in each country. As this is the case, certain adaptation methods must be taken to minimize the vulnerability of the population.

5.2: Adaption to Climate Change and Migration

As climate change effects Egypt and Morocco, adaptation methods must be taken into account to mitigate its effects. While the scenarios of climate change and its effects presented earlier in this chapter may hold true, possible adaptation methods could minimize the number of individuals that are vulnerable. Vulnerability is a critical aspect of the climate change migration nexus. In both cases of Egypt and Morocco, the vulnerability of certain groups of people (mainly low skilled, low-income individuals) is what instigates the most amount of migrants. Both short term and long term methods can help countries such as Egypt and Morocco cope with climate change and reduce the vulnerability of low income people. Adaptation can reduce the impact that climate change has on economies and in turn migration. Regarding Egypt and Morocco, adaptation methods will have to take into consideration increases in urbanization and development as the population and size of cities will continue to increase.

One of the most important aspects of adapting to climate change will be for societies to set goals and priorities. Setting goals and priorities are the first steps to establishing effective climate change adaptation techniques. If governments can recognize which sectors of the economy are at high risk to be impacted by climate change, adaptation methods can be intensified in specific areas. In the case of Egypt and Morocco, coastal vulnerability, water availability, and agriculture are areas that should be priorities regarding climate change adaptation. By prioritizing these sectors of the economy, governments can set goals that will reduce the vulnerability of these sectors. These parts of each country will impact the most individuals and will likely displace the most individuals. One of the issues that present itself when understanding climate change adaptation is the dimension of uncertainty that still exists. While projections of climate change based on current findings can be relied on, they are

uncertain predictors of the most unpredictable events on Earth. With this being the case, countries such as Egypt and Morocco should take measures to account for uncertainty, but should not ignore projections. This includes being flexible and being able to sustain resources in the event of any climactic disaster. While uncertainty is indeed a factor that plays into adaptation, three known parts of the Egyptian and Moroccan economy will be affected. The first of which is the impact of climate change on the coastlines of both countries.

The coast of both countries is likely to be negatively affected by climate change in the future. The reason why the coast is so important is due to the portion of the population, and economy that certain coastal cities support. This is especially the case in Morocco where the majority of the population live in coastal cities. Egypt, on the other hand, does not have a significant portion of its population living on the coast; however, the coast is a major driver of the economy. The coastlines play a major role in the social and economic landscape of both countries which influence migration trends. If adaptation to climate change along the coast is not made a priority, there can be several implications on migration patterns for both countries. To minimize vulnerability to climate change along the coast, certain adaptation methods include urban planning, investments in physical capital, and institutional preparedness or emergency plans. As mentioned earlier the urban population of both countries continues to increase dramatically. For this reason, urban planning must be a priority to adapt to climate change and increased migration to these urban areas. Zoning regulations must be taken into account, along with limiting redevelopment projects in areas that are highly vulnerable to climate change. Along with urban planning, investment in physical capital is also necessary. These investments include coastal defenses such as sea walls and dikes that protect large portions of the population from disasters such as floods or storm surges. Other investments include ensuring that infrastructure

essential for urban development is renovated to cope with potential climate disasters. This includes investments in public facilities such as schools, hospitals, and or residential buildings. If the infrastructure can withstand the effects of climate change, individuals and families will have less incentive to migrate. Often houses and other buildings are made mostly of clay which can deteriorate very easily in the events of floods, or extreme temperatures. Another investment that is crucial is the development, and renovation of drainage systems. This would limit the effects that flooding would have in these cities, and water that does come from flooding could be treated to serve the needs of particular sectors of the economy. Drainage systems in both Morocco and Egypt are outdated making the countries more vulnerable to the effects of sudden onset disasters like flooding. Alongside these investments, emergency plans for evacuation and institutional preparedness for climate disasters should be improved. If more of the population were equipped and prepared for weather disasters, a smaller portion of the population would be affected. Morocco and Egypt should develop warning systems to notify areas that are vulnerable to flash floods or storm surges. These investments and adaptation strategies are ones that could be difference makers regarding climate change adaptation. These investments and adaptations support urban development and also sustain stable levels of migration. These investments have the ability to minimize vulnerability along the coast which would lower internal and international migration.

One of the main sectors of both economies that should be adapted to climate change is agriculture. Throughout this paper, agriculture has been mentioned as one of the most vulnerable aspects of each economy. Since climate change will reduce agricultural production in both countries, similar adaptation methods can be used to minimize the effects of climate change. In both countries, the adaptation methods used should be relatively simple, inexpensive, and local.

This includes educating the population of climate change especially low-skilled workers. By educating the population involved in the agricultural sector, these countries can make individuals aware of the effects that the climate can have on their farms and crops. Classes on climate change and low-cost adaptation methods would provide low-skilled, low-income individuals with the knowledge necessary to potentially save their crops or farms in the short term. Many low-skilled individuals have not been exposed to any tertiary education which can attribute to why many individuals migrate so suddenly. If individuals are educated on how to sustain farms or crops using low-cost adaptation methods, the chances of migration become lower. Another viable adaptation option would be to creating adaptation funds and or insurance funds for climate disasters. These funds and insurance should be investments made by the government to compensate or aid those whose land is negatively affected by climate disasters. These funds and forms of insurance would, in turn, minimize the individuals that choose to migrate. Individuals that have farms impacted by climate change are not compensated for their losses, giving them little to no choice but to migrate. If these individuals were able to recover from their losses, there would be a lower chance that these individuals leave the affected area. Another major adaptation should be to restructure and improve irrigation systems and filtration systems. This applies more to Egypt since all farmable land is irrigated, whereas in Morocco a small portion of land is irrigated. Since so much water is used in agriculture in Egypt, it should be a priority to change or enhance irrigation methods to make water use more efficient. Irrigation systems and filtration systems are outdated throughout both countries meaning that water is not being used as efficient as possible. Regarding Morocco, the country should make more land used for agriculture irrigated. Since Morocco is subject to declines in rainfall, this would be an alternative to the low levels of rainfall that are projected in the future. If these systems are "fixed" or improved,

agricultural production could also increase. This is another possible adaptation method. If agricultural production is increased during growing seasons, then the economy would be able to withstand the losses within the agricultural sector due to climate change. The government could support increased production during growing seasons to counteract the effects of climate change. While this can be an alternative, agriculture is suffering in the first place due to increased land usage, and production. Increasing production would help the economy and migration trends in the short run, but would likely intensify the effects of climate change in the long run. Moreover, another possible adaptation method could be to develop crops that are heat and saline tolerant. If a wider variety of crops that are resistant to certain heat or saline levels are used, then the losses would be reduced even further. These adaptation methods within the agricultural sector have the ability to reduce both economic and social vulnerability. If these adaptation methods are implemented and used, then migration would become a less appealing option for low-skilled individuals affected by climate change. Ideally, individuals from Egypt or Morocco would choose to remain in the area and withstand climate change rather than moving to other areas. If the impacts on the agricultural sector due to climate change can be mitigated, then individuals will remain in the country rather than moving elsewhere in or out the country. If the effects of climate change on agriculture are adapted to, migration levels can remain relatively stable allowing rural areas do develop further.

While agriculture is one of the main sectors of the economy that will be influenced by climate change, water availability is the other issue that is present all throughout the MENA region. While some water adaptation methods differ from Egypt to Morocco, they are both necessarily the same. One adaptation methods to cope with water stress is the option to make water tradable. This refers to those individuals or users who have water allocated to them. By

doing this, these users could trade their water rights to other individuals. This results in water to be reallocated to higher value uses (Smith et al., 2013). Another form of adaptation is reusing water at a higher efficiency. This means that water used for irrigation and agriculture should not be held to the same standards as drinking water. Water that is used by industry, and or agriculture should be treated and reused once again. By doing this, water stress decreases throughout both countries. Especially in Egypt, reusing water could be beneficial since most of the water is taken from the Nile. Improved filtration systems could result in more water available for agriculture, and other parts of industry. This will lead to higher economic production if water is reused at a higher rate of efficiency. Apart from reusing water, another form of adaptation is increased public awareness. If more of the population is made aware of water stress, it could lead to a possible increase in efficiency. This goes hand in hand with the adaptation methods mentioned in the agriculture section. If classes are held, and awareness is raised, the chances of decreasing water stress increases. Overall these are the primary adaptation methods that can be put in place to reduce water stress from climate change. As mention before water stress is directly correlated to agriculture. Some adaptation methods are similar and can be interchangeable between the two.

These adaptation methods previously mentioned will all help mitigate the effects of climate change along the coast, in the agricultural sector, and reduce water stress in both countries. If vulnerability in these three areas of each economy is reduced, then the likelihood of internal and international migration will be minimized. As mentioned earlier, sudden onset disasters are the only dimensions of climate change that will displace individuals in the short-term. Climate change is likely to intensify existing issues throughout both countries which will in turn influence migration. If these adaptation methods are used, certain demographic issues that may increase migration rates could be resolved. Adaptation to climate change is imperative if

developing countries such as Morocco and Egypt would like to see continued urban development, and lowered levels of brain drain. Domestic improvements to accommodate the population is one of the main ways that internal and international migration can be stabilized in the near future.

Conclusion

As climate change takes its effect over the course of the century, Egypt and Morocco will have to use some of the previously mention adaptation techniques to mitigate the effects of climate change. These adaptations to climate change will limit the effect it has on the economic, political, and social landscape of these countries. However, there have been dramatic changes to climate change and migration policies within the last ten years that adequately address these issues. Currently, countries have come together to create programs, and action plans to manage and address environmentally-induced migration. One change includes the adoption of The National Adaption Programmes of Action (NAPA) which are the principle frameworks adopted by less developed countries manage environmentally induced migration (Tangermann et al., 2016). The purpose of these principles is to provide less developed countries with a process to identify activities needed to adapt to climate change. Recently in 2015, 196 countries signed the Paris Agreement to cut greenhouse gas emissions, and to keep global temperature rise well below two degrees Celsius. Egypt and Morocco were two countries on this list, and have set goals to reduce carbon emissions. Currently, Egypt has taken up projects to reduce carbon emissions, and a National Capacity Self-Assessment (NCSA) was taken to understand the effects of climate change throughout the country. The self-assessment aims to improve data management, delineating the monitoring and reporting roles of different concerned entities, and ensuring

financial stability for environmental monitoring (Chachibaia, 2009). Regarding migration, Egypt has just passed laws that have severe repercussions for human traffickers and those that aid human trafficking. This law limits the amount of illegal migration that originates in Egypt, and at the same time, the law offers protection for asylum seekers, and refugees. This law change going forward will be crucial as climate change increases levels of migration. While Egypt has been taking the initiative to change climate change and migration policies, Morocco has been outperforming Egypt in terms of policy changes. Morocco recently held the Twenty-second Conference of the Parties (COP22) of the United Nations Framework Convention on Climate Change (UNFCCC) in Marrakesh in 2016. This conference is held every year to monitor countries progress with reducing climate change. This initiative to host the conference shows how devoted the country is to reducing the effects of climate change. Also, Morocco recently became the first African country not to use any fossil resources. In 2013, Morocco pledged a substantial reduction of fossil fuel subsidies to contrast the growing budget deficit resulting from the heavy subsidization. Morocco also set a target of 50 percent of installed electricity production capacity by sources of renewable energy by 2025, together with a reduction in energy consumption of 15 percent by 2030 (Calliari, 2016). Morocco has made improvements to battle climate change and has set goals to reduce carbon emissions further. Regarding migration, Morocco has made changes to reduce irregular migration to Morocco, and illegal migration to Europe. To reduce illegal migration to Europe, Morocco and Spain have come to terms to increase security in nearby enclaves, and around their respective coasts. In addition to this, King Mohammad has reduced restrictions on asylum seekers coming to Morocco allowing over 18,000 migrants to be granted asylum to Morocco. By doing this, the influx of irregular migration is monitored and regulated efficiently. Furthermore, both countries have taken positive

actions to reduce climate change and irregular migration. While this is the case, policies regarding environmental migration have been discussed minimally due to the lack of evidence. To spur increased policy changes to support those displaced by climate change, more research must be done to create substantial evidence to support the idea that there is indeed a nexus between migration and climate change. Once sufficient evidence is gathered, countries that are most vulnerable to climate-induced migration (including Morocco and Egypt) can make the necessary changes to migration and climate change policies.

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